Revisional notes on the species-group of *Saturnia grotei* Moore, 1859 of the genus *Saturnia* Schrank, 1802 (Lepidoptera: Saturniidae)

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Abstract: The taxa belonging to the species-group of *Saturnia grotei* are catalogued in order of publication. **Lectotypes are designated** for: *Saturnia grotei* Moore, 1859 (male, in London), *Saturnia anna* Atkinson (*in* Moore), 1865 (male, in Berlin), *Saturnia bieti* Oberthür, 1886 (female, in London), *Caligula anna yunnana* Mell, 1939 (male, in Bonn) and *Caligula anna tsinlingshanis* Mell, 1939 (male, in Bonn). A **neotype male is designated** for *Caligula anna dejeani* Bouvier & Riel, 1931 to stabilize nomenclature (in Frankfurt am Main), because the original type material is lost. Revisional notes on the species including descriptions of 4 new species: *Saturnia* ***paragrotei*** **sp. n.** (HT male, in Berlin), *S.* ***rosalata*** **sp. n.** (HT male, in Frankfurt), *S.* ***tibetanna*** **sp. n.** (HT male, in Berlin) and *S.* ***sinanna*** **sp. n.** (HT male, in Frankfurt), are provided, including new information on the preimaginal morphology of some species. All species and, where known, preimaginal instars are illustrated, as well as male genitalia. The phylogeny of the group is shortly discussed, based on morphology and DNA barcode. A checklist of the revised species-group (with new synonymies and revised combinations) is provided at the end of the publication.

Key words: *Saturnia, Rinaca,* new species, revision, Himalaya, Afghanistan, Pakistan, India, Arunachal Pradesh, West Bengal, Sikkim, Nagaland, Nepal, Bhutan, Tibet, China, Yunnan, Sichuan, Shaanxi, Guanxi, Gansu, Myanmar, Vietnam, morphology, biogeography, mtDNA COI barcode.

Anmerkungen zu einer Revision der Artengruppe um *Saturnia grotei* Moore, 1859 der Gattung *Saturnia* Schrank, 1802 (Lepidoptera: Saturniidae)

Zusammenfassung: Ein Katalog der Taxa der Artengruppe von *Saturnia grotei* in der Reihenfolge des Erscheinens wird gegeben. **Lectotypen werden designiert** für: *Saturnia grotei* Moore, 1859 (Männchen, in London), *Saturnia anna* Atkinson (*in* Moore), 1865 (Männchen, in Berlin), *Saturnia bieti* Oberthür, 1886 (Weibchen, in London), *Caligula anna yunnana* Mell, 1939 (Männchen, in Bonn) und *Caligula anna tsinlingshanis* Mell, 1939 (Männchen, in Bonn). Ein männlicher **Neotypus wird designiert** für *Caligula anna dejeani* Bouvier & Riel, 1931, um die Stabilität der Nomenklatur zu gewährleisten, da das Originalmaterial verloren ist (in Frankfurt am Main). Bei der Revision der Gruppe werden die folgenden 4 neuen Arten beschrieben: *Saturnia* ***paragrotei*** **sp. n.** (HT Männchen, in Berlin), *S.* ***rosalata*** **sp. n.** (HT Männchen, in Frankfurt), *S.* ***tibetanna*** **sp. n.** (HT Männchen, in Berlin) und *S.* ***sinanna*** **sp. n.** (HT Männchen, in Frankfurt). Dazu gibt es neue Informationen über die Präimaginalmorphologie einiger Arten. Alle Arten und, soweit bekannt, ihre Präimaginalstadien sowie männliche Genitalarmaturen werden abgebildet. Die Phylogenie der Gruppe wird kurz diskutiert, basierend hauptsächlich auf Morphologie und DNA-Barcode. Eine Liste aller Taxa der revidierten Artengruppe (mit neuen Synonymien und revidierten Kombinationen) wird am Ende des Textes gegeben.

Introduction

During the recent ca. 60 years, the genus *Saturnia* von Paula Schrank, 1802 *sensu lato* was re-organized by different authors (e.g., Michener 1952, Ferguson 1971/72, Lemaire 1978, Nässig 1994a). The species-group[3] of *grotei* Moore, 1859 (comprising the species-complexes[3] of *grotei* Moore, 1859 and *anna* Atkinson [*in* Moore], 1865) was combined during that process with the subgenus *Rinaca* Walker, 1855 within *Saturnia* due to characters of habitus and ♂ genitalia morphology.

The *grotei*-group of *Saturnia,* named after the oldest taxon included, *S. grotei* Moore, 1859, is apparently monophyletic; this view is supported by all different methodological approaches applied so far. The species-group of *grotei* comprises usually mountain species, ranging from medium to high elevations. The species-complex of *grotei* is a Himalayan faunal element with somehow limited distribution from Afghanistan and the NW Himalaya to Bhutan, that of *anna* is more widely found across the mountains of continental southern Asia from the central and eastern Himalaya to Central China and Vietnam.

In the present publication we try to analyse the status of the different populations belonging to the group, based on external (habitus) and genitalia morphology, DNA sequences (the so-called barcode, see Ratnasingham & Hebert 2007; in the web: Barcode of life 2010) of the mitochondrial cytochrome-*c* oxydase gene, subunit I (= COI), biogeography, and other available information. Additionally the available information about the preimaginal morphology of some taxa is also included, based on several rearing attempts by the senior author and others (see also Nässig 1983).

[1] 18th contribution to the Saturniidae fauna of China. (17th contribution: Naumann, S. & Löffler, S. (2010): Notes on the Asian genus *Cricula* Walker, 1855, with description of new species (Lepidoptera, Saturniidae). – Neue Entomologische Nachrichten, Marktleuthen, **Supplement 2:** 1–24.)

[2] 73rd contribution to the knowledge of the Saturniidae. (72nd contribution: Naumann, S., Nässig, W. A., & Löffler, S. (2008): Notes on the identity of *Loepa katinka diversiocellata* Bryk, 1944 and description of a new species, with notes on preimaginal morphology and some taxonomic remarks on other species (Lepidoptera: Saturniidae). – Nachrichten des Entomologischen Vereins Apollo, Frankfurt am Main, N.F. **29** (3): 149–162.)

[3] The expressions "species-group" and, subordinate to this, "species-complex" are used in this publication as tentative informal groupings of species which are deemed to be closely related to each other and supposedly monophyletic. However, these groupings are here not intended to be published for the purpose of zoological nomenclature (ICZN 1999: Art. 8.2.; disclaimer), and these collective group names, therefore, do not enter into the genus-group of names in zoology (ICZN 1999: Art. 10.3., 10.4.).

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We began our research ca. in 1995 and, after having studied most of the types (and taken "classical" photos on colour slides from them; this is the cause why we do not show all types here, our illustrations here are based on more recent digital images) and a large amount of specimens from different areas, in the early 2000s eventually came to the conclusion to interprete the *grotei*-complex and the *anna*-complex each to consist of 3 closely related, often parapatric species, summing up to 6 species in total. At that time we also included, in a somehow tentative arrangement, *Saturnia kitchingi* Brechlin, 2001 and *S. nanlingensis* Brechlin, 2004 as 7th and 8th members of the group. This was mainly an interpretation of the situation on the level of morphospecies, based primarily on specimens in collections, and of the supposed diurnal activity of the ♂♂.

However, these interpretations were not always fully conclusive, and so we waited for another period and hoped for new material and the adoption of new methods. Recently we started sending legs of dried specimens to the "Canadian Centre for DNA Barcoding" (CCDB) in Guelph, Ontario, for sequencing and analysing using the 648 base pairs (bp) of the barcode fragment of the mtDNA COI gene. DNA was extracted from legs of dried specimens in the collections of the authors and others. Technical details of extraction and amplification and sequencing protocols can be found on the CCDB website (CCDB 2010) and are also described, e.g., in Vaglia et al. (2008).

The two species-complexes within the group appear to be well separated. However, within the two species-complexes, some taxa on species level are evidently so closely related (and in terms of evolution so young) that, without knowing further details (especially behavioural and biological isolation factors), an interpretation as subspecies (on the basis of both morphology and barcode) would as well have been justifiable — except for those which live locally sympatric with their relatives (see distribution data below in the text; there is considerable overlap of several of the species) and, therefore, can only be interpreted as distinct, separate species, although a clear morphological differentiation may be problematic sometimes. On the other hand, specimens nearly indistinguishable on morphological level sometimes showed surprising large differences (> 2 %, in part 3 %) in the mtDNA barcode sequences (see Fig. 1). The interpretation published here is the result of our present data and discussion; however, it is still somehow provisional, and further research is necessary to assess the situation in more detail. It would also be very helpful if more of the different populations could be reared (thereby also studying the preimaginal morphology — unlabelled and unnamed or misidentified pictures of larvae found in the internet suggest a possibly wider larval variability of different species and/or populations within the group), and additional analyses of other DNA sequences or, e.g., alloenzymes or pheromones, and perhaps further supporting behavioural and other studies could also be helpful.

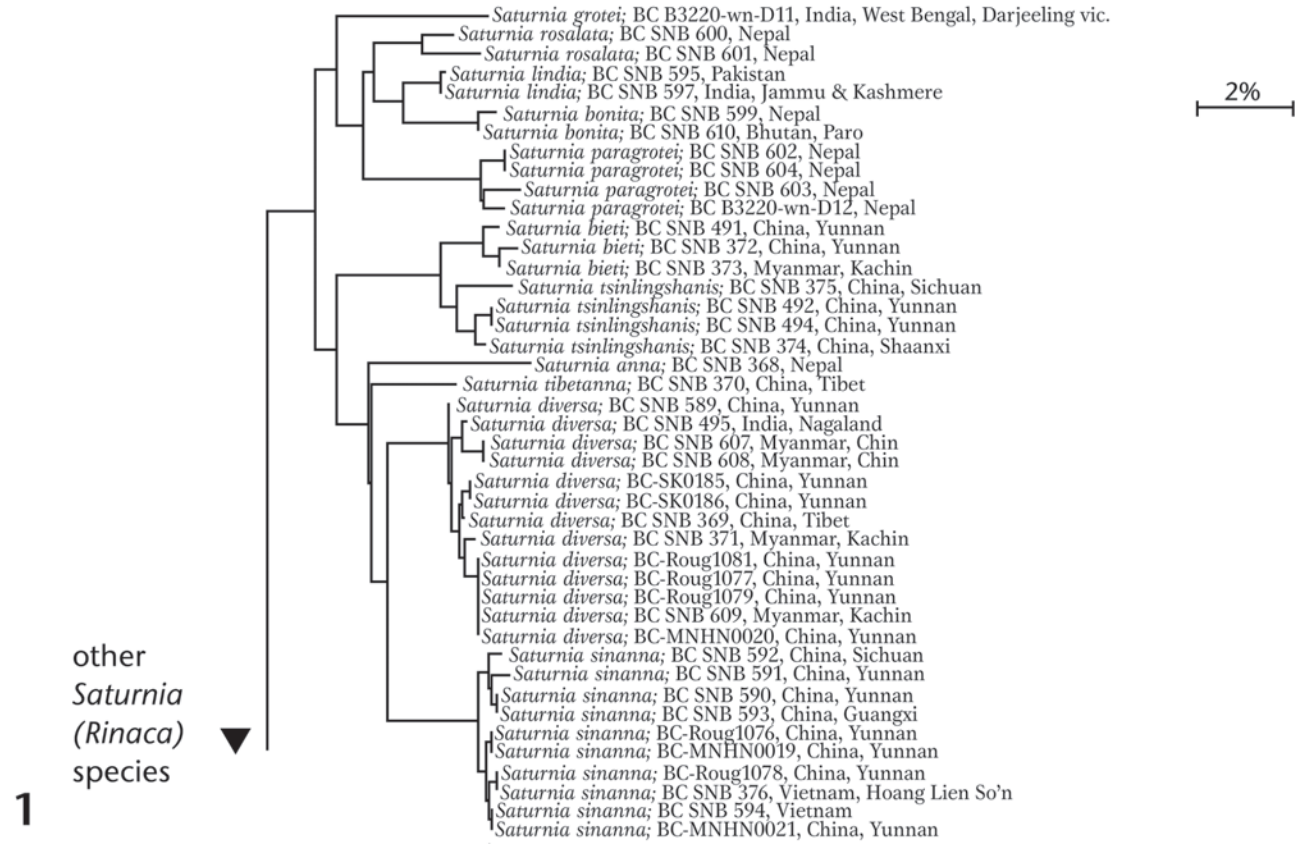
Saturnia grotei; BC B3220-wn-D11, India, West Bengal, Darjeeling vic.
Saturnia rosalata; BC SNB 600, Nepal
Saturnia rosalata; BC SNB 601, Nepal
Saturnia lindia; BC SNB 595, Pakistan
Saturnia lindia; BC SNB 597, India, Jammu & Kashmere
Saturnia bonita; BC SNB 599, Nepal
Saturnia bonita; BC SNB 610, Bhutan, Paro
Saturnia paragrotei; BC SNB 602, Nepal
Saturnia paragrotei; BC SNB 604, Nepal
Saturnia paragrotei; BC SNB 603, Nepal
Saturnia paragrotei; BC B3220-wn-D12, Nepal
Saturnia bieti; BC SNB 491, China, Yunnan
Saturnia bieti; BC SNB 372, China, Yunnan
Saturnia bieti; BC SNB 373, Myanmar, Kachin
Saturnia tsinlingshanis; BC SNB 375, China, Sichuan
Saturnia tsinlingshanis; BC SNB 492, China, Yunnan
Saturnia tsinlingshanis; BC SNB 494, China, Yunnan
Saturnia tsinlingshanis; BC SNB 374, China, Shaanxi
Saturnia anna; BC SNB 368, Nepal
Saturnia tibetanna; BC SNB 370, China, Tibet
Saturnia diversa; BC SNB 589, China, Yunnan
Saturnia diversa; BC SNB 495, India, Nagaland
Saturnia diversa; BC SNB 607, Myanmar, Chin
Saturnia diversa; BC SNB 608, Myanmar, Chin
Saturnia diversa; BC-SK0185, China, Yunnan
Saturnia diversa; BC-SK0186, China, Yunnan
Saturnia diversa; BC SNB 369, China, Tibet
Saturnia diversa; BC SNB 371, Myanmar, Kachin
Saturnia diversa; BC-Roug1081, China, Yunnan
Saturnia diversa; BC-Roug1077, China, Yunnan
Saturnia diversa; BC-Roug1079, China, Yunnan
Saturnia diversa; BC SNB 609, Myanmar, Kachin
Saturnia diversa; BC-MNHN0020, China, Yunnan
Saturnia sinanna; BC SNB 592, China, Sichuan
Saturnia sinanna; BC SNB 591, China, Yunnan
Saturnia sinanna; BC SNB 590, China, Yunnan
Saturnia sinanna; BC SNB 593, China, Guangxi
Saturnia sinanna; BC-Roug1076, China, Yunnan
Saturnia sinanna; BC-MNHN0019, China, Yunnan
Saturnia sinanna; BC-Roug1078, China, Yunnan
Saturnia sinanna; BC SNB 376, Vietnam, Hoang Lien So'n
Saturnia sinanna; BC SNB 594, Vietnam
Saturnia sinanna; BC-MNHN0021, China, Yunnan
2%
other
Saturnia
(Rinaca)
species
1

Fig. 1: Neighbour Joining tree ("BOLD TaxonID Tree" = sequence similarity tree, distance model: Kimura 2 parameter) of the species-group of *Saturnia grotei*. Extracted from a partial tree of Saturniinae (genera: *Saturnia*-group of genera, *Cricula, Solus, Antheraea*) downloaded on 20. vi. 2010. — Legends: actual name of taxon, BC code no., approx. locality of origin.

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The results of the barcode studies (and as well other DNA-based studies, e.g., Regier et al. 2002, 2008) on a higher taxonomic level also indicated that the genus *Saturnia* (*sensu lato*), as understood presently (Nässig 1994a), may be more complex than expected before, and the genus *Lemaireia* Nässig & Holloway (*in* Holloway), 1987 may possibly also merge in here (supported both by unpublished barcode data and larval morphology; see Nässig & Holloway 1988, Lampe & Nässig 1989, Pinratana & Lampe 1990, Peigler & Wang 1996, Nässig et al. 1996, Paukstadt & Paukstadt 2009, Lampe 2010). The subgeneric classification within *Saturnia* thus requires a general reassessment and probably some modification. As a consequence, we here provisionally do not apply a subgeneric name (although we believe that *Rinaca* is still the adequate subgeneric name for the *grotei*-group). However, as the use of the COI barcode sequences for higher taxonomic levels often is problematic, we do not intend to go deeper into details here and wait for further analyses.

Abbreviations and conventions

Abbreviations of collections:

BMNH The Natural History Museum, London (formerly British Museum (Natural History)), U.K.

CAHS Collection Armin Hauenstein, Schönenberg, Germany.

CMWM Collection Museum Thomas J. Witt, Munich (assigned to ZSM), Germany. (The Saturniidae of CMWM were not studied by us because, according to T. J. Witt [pers. comm.], the CMWM saturniid collection is "exclusively" to be studied by R. Brechlin.)

CSKK Collection Steve Kohll, Kayl, Luxembourg.

CSLL Collection Swen Löffler, Lichtenstein/Sachsen, Germany.

CSNB Collection Stefan Naumann, Berlin, Germany.

CWAN Collection Wolfgang A. Nässig, now in SMFL.

ETHZ Eidgenössische Technische Hochschule Zürich, Switzerland.

MHNG Muséum d'Histoire Naturelle de Genève, Switzerland.

MHNL Muséum d'Histoire Naturelle de Lyon, France.

MNHN Muséum National d'Histoire Naturelle, Laboratoire d'Entomologie, Paris, France.

NHMW Naturhistorisches Museum Wien (Vienna), Austria.

NRSS Naturhistoriska Riksmuseet, Stockholm, Sweden.

SMFL Senckenberg-Museum, Lepidoptera collection, Frankfurt am Main, Germany.

ZFMK Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn, Germany.

ZMA Zoölogisch Museum, Amsterdam, The Netherlands.

ZMHU Zoologisches Museum der Humboldt-Universität, Berlin, Germany.

ZSM Zoologische Staatssammlungen München (Munich), Germany.

Other abbreviations and conventions:

‡ Unavailable name.

BC [no.] Barcode [with number].

Fw. Forewing.

GP [no.] Genitalia dissection [with number] (Genitalpräparatenummer).

GP1/2 Genitalia plates 1/2.

HT Holotype.

Hw. Hindwing.

Lfw. Length of the forewing, measured in a straight line from the base of the wing to the most distant point of the apex, without the width of the thorax.

L.t./l.t. Locus typicus.

LT Lectotype.

NT Neotype.

PIP I/II Preimaginal plates I/II.

PLT Paralectotype(s).

PT Paratype(s).

ST Syntype(s).

uns. underside.

ups. upperside.

Illustration codes: Figures without additions ("Fig. *[n]*") are either textfigure 1 (= the barcode similarity tree) or imaginal illustrations of set specimens (= Figs. 2–74) on colour plates 1–4. Preimaginal figures are found under "Fig. PIP I/II: *[letter]*" on preimaginal plates I and II. Genitalia figures are found under "Fig. GP1/2: *[n]*" on genitalia plates 1 and 2. Maps 1–3 are numbered as such.

The species-group of *S. grotei* — an annotated catalogue of the existant taxa

Since Bryk (1944), the species-group of *Saturnia grotei* comprises 11 names, listed here in chronological order of their publication:

1. *grotei* Moore, 1859

Saturnia grotei Moore (1859: 265; Annulosa pl. LXV, fig. 2; this picture is reprinted here, see Fig. 2). — LT ♂ **by present designation,** in BMNH [examined]. — L.t.: [N-India, West Bengal], Darjeeling.

Type material. Moore (1859) did not specify the number of ♂ specimens studied by him, although he possibly had only one specimen before him (therefore this is a ST); a LT was obviously never designated (see, e.g., Kirby 1892 or Hampson 1893). Butler (1881: 61–62, pl. XCIV, fig. 3) had an original ♂ from the India House Museum before him (but did not specifically designate this as LT, in spite of the title of his contribution), and for fixing the type locality to Darjeeling, this ♂ specimen illustrated by him is thus here **designated as lectotype,** in BMNH; examined. — In later British publications this Darjeeling specimen was rarely cited again.

Nomenclatural note. The taxon *grotei* is often incorrectly cited with the authorship "Moore, 1858" (see, e.g., Brechlin 2001 for a recent citation). However, this is based on an erroneous interpretation of the publication dates of Moore (1859) and Moore *in* Horsfield & Moore (1860): the catalogue of Horsfield & Moore was often incorrectly cited as being published in "1858–59", but according to Hampson (1893), Cowan (1975) and Fletcher & Nye (1982: 92, for *Loepa* Moore, 1859), it was only publically available in 1860, and so the synopsis by Moore published in 1859 takes priority (for details see Nässig 2007 regarding the genus *Loepa;* this is an analogous case with the same publications involved).

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2. *lindia* Moore, 1865

Saturnia lindia Moore (1865a: 424, pl. XXII, fig. 3). – LT ♂ (designated by Brechlin 2001: 96, fig. 9), in BMNH; examined. – L.t.: „NE-India".

3. *anna* Atkinson (*in* Moore), 1865

Saturnia anna Atkinson *in* Moore (1865b: 818). – Fig. 3: LT ♂ **by present designation,** in ZMHU [examined]. – L.t.: "Darjeeling" [= N-India, West Bengal].

Type material. The species was described after an unspecified number of specimens; Moore only wrote "In coll. W. S. Atkinson, Esq.", without giving a number; the name *anna* was chosen following a manuscript name of W. S. Atkinson. Parts of the collection of Atkinson came into ZMHU, Berlin, either via O. Staudinger or directly (Horn & Kahle 1935, Horn et al. 1990). 2 ♂♂ labelled [syn-]"types" ex coll. Atkinson are today deposited in coll. Staudinger in ZMHU (examined). It might be concluded from Moore's text in the original description that he possibly had seen only one ♂ specimen, but this is not expressly said, and the 2 specimens are therefore dealt with as STs. There is most likely no chance to find out which of the Atkinson specimens preserved today was the possible singleton seen by him. Therefore, the ♂ with the following labels: "*Saturnia anna* Atkn. (Type lot a)", "coll. Atkinson", "Darjeeling (at light) Ap[ri]l 29. [18]64", "♂", "origin" [red], and "*Anna* Atks." plus affixed dried genitalia preparation (probably by Mell) is **herewith designated as lectotype** of *Saturnia anna* Atkinson *in* Moore to stabilize current use of the name (Fig. 3). The second specimen with labels: "coll. Atkinson", "Darjeeling (at light) June 26. [18]64", "origin" [red], "*C. anna anna* Mr. Typus" [red underlined; handwritten by Mell?], plus again dried genitalia preparation automatically becomes a PLT thereby (Fig. 4). Labels will be added accordingly.

Nomenclatural note. Brechlin & Kitching (2010: 15) discussed a similar case of authorship problems for the species name *miranda* (in genus *Loepa* Moore, 1859). They interpreted the citation "*Loepa miranda* Atkinson *in* Moore, 1865[a]" to be incorrect. However, the Code (ICZN 1999) states in Article 50.1.1 explicitly: *"if it is clear from the contents that some person other than an author of the work is alone responsible both for the name or act and for satisfying the criteria of availability other than actual publication, then that other person is the author of the name or act. If the identity of that other person is not explicit in the work itself, then the author is deemed to be the person who publishes the work."* – When Moore (1865b) in his contribution explicitly differentiates new taxa being either just a "n. sp." (i.e., with his own authorship) or, in contrast, being created by someone else and not by himself, with the material coming from the other person, this article clearly applies, and the authorship "Atkinson *in* Moore", therefore, is correct in both cases (for *Loepa miranda* as well as *Saturnia anna,* and, of course, also in other such cases, such as *Loepa sikkima* Atkinson [*in* Moore 1865b: 818] for another saturniid example). This is also indicated by the labelling of the specimens, see below, and in some cases Moore (1865b) in his text even cites directly from written information ("in epistolâ") by Atkinson.

4. *bieti* Oberthür, 1886

Saturnia bieti Oberthür (1886: 31; pl. 7, fig. 58). – LT ♀ **by present designation,** in BMNH [examined]; Fig. 5: reproduction of the original illustration by Oberthür (1886: pl. 7, fig. 58). – L.t.: [China], "Thibet"; exact locality nowhere given in detail within Oberthür's publication, most probably somewhere in E Tibet [= Xizang Zizhiqu] or NW Yunnan or SW Sichuan.

Type material. The species was described after 1 ♂ and 1 ♀, of which the ♀ is figured with later added abdomen (compare fig. in Oberthür 1886, here Fig. 5). The ♀ ST specimen with label text: "Syntype" [blue], "*Saturnia bieti* Ch. Oberthür, Lepid. du Thibet. Déc. 1886, Type figuré Pl. VII Fig. 58", "coll. Ch. Oberthür", and "Rothsch. Bequest B.M. 1939-1" is deposited in BMNH (examined), and fits well with the colour drawing in the original description by Oberthür. This specimen **hereby is designated as lectotype** of *S. bieti,* a label will be added accordingly. So far, the ♂ ST could not be located; this specimen represents the single PLT. – A further ♀ in BMNH with label text: "Paratype" [yellow], "*Caligula bieti* (Obth.)" [handwritten], "Paratype" [red], "Thibet, Tà-tsien-loû, Mai, Juin 1892 Chasseurs Thibetains", "Levick Bequest 1941-83", and "This specimen is not a paratype of *S. bieti* Oberthür" [handwriting, writer not identified], was collected after publication of the original description and is no type specimen of *S. bieti* as already written on one of its labels. D'Abrera (1998: 36) figured just this specimen again in error as "paratype ♀ of *S. bieti*".

5. *hockingii* Moore, 1888

Saturnia hockingii Moore (1888: 402). – LT ♂ (designated by Brechlin 2001: 97, figs. 11, 30), in BMNH; examined. – L.t.: „Kullu" [India, NW-Himalaya, Himachal Pradesh].

6. *bonita* Jordan, 1911

Caligula lindia bonita Jordan (1911: 218). – LT ♂ (designated by Brechlin 2001: 97, figs. 13, 29), in BMNH; examined. – L.t.: „Yatung [= Yadong], Tibet".

7. *dejeani* Bouvier & Riel, 1931

Caligula anna [var.] *dejeani* Bouvier & Riel (1931a: 47 [not illustrated]). – This name was proposed conditionally, but this alone does not denie its availability (ICZN 1999, Art. 11.5.1). – Fig. 6: **NT** ♂ (designated below), in SMFL. – L.t. see below (by NT designation).

Type material. The taxon was originally described after 1 ♂ and 2 ♀♀, collected by local collectors and sent to Europe by P. Déjean in 1904, said to be in coll. Oberthür. We have searched the collections of BMNH, MNHN, MHNL and MHNG and many other museums in Europe (with the help of their curators), but did not find these type specimens of Bouvier & Riel. A former entomological collection in Rennes (originally curated by the Société Scientifique de Bretagne), where parts of the Oberthür collection might have as well been deposited, does no longer exist (pers. comm. H. Labrique, Lyon). Accordingly, the 3 ST specimens of *dejeani* Bouvier & Riel are obviously lost. Therefore we decided to designate a NT specimen to clarify the taxonomic status of the nominal taxon *dejeani* and stabilisz the current usage of the different names involved, because in the area of Ta-Tsien-Lou (= China, Sichuan, Kangting [Chinese name] = Dartsemdo [Tibetan name], ca. 30°2′ N, 102°2′ E; see Wagener 1959–61) provided by Bouvier & Riel as locality for *dejeani,* more than one species of the *anna*-complex is known to exist, and *dejeani* was never illustrated and thus may be confounded with other species in the complex. **Neotype by present designation:** we select a specimen (see Fig. 6) in SMFL which originates from the same locality as the lost STs and was also imported via P. Déjean in 1903, and surely belongs to the same population as the lost STs. It has the following labels (Fig. 6b): "Ta-tsien-Loû, Chasseurs Indigènes du P. Déjean, 1903" [white, printed]; "Ex coll. Ch. Oberthür" [white, printed]; "*bieti* Obth. Cotypen!!" [sic; white, handwritten, writer not identified]; "896." [white, printed]; "Coll. C. Commerell" [white, printed]; in SMFL. A red NT label

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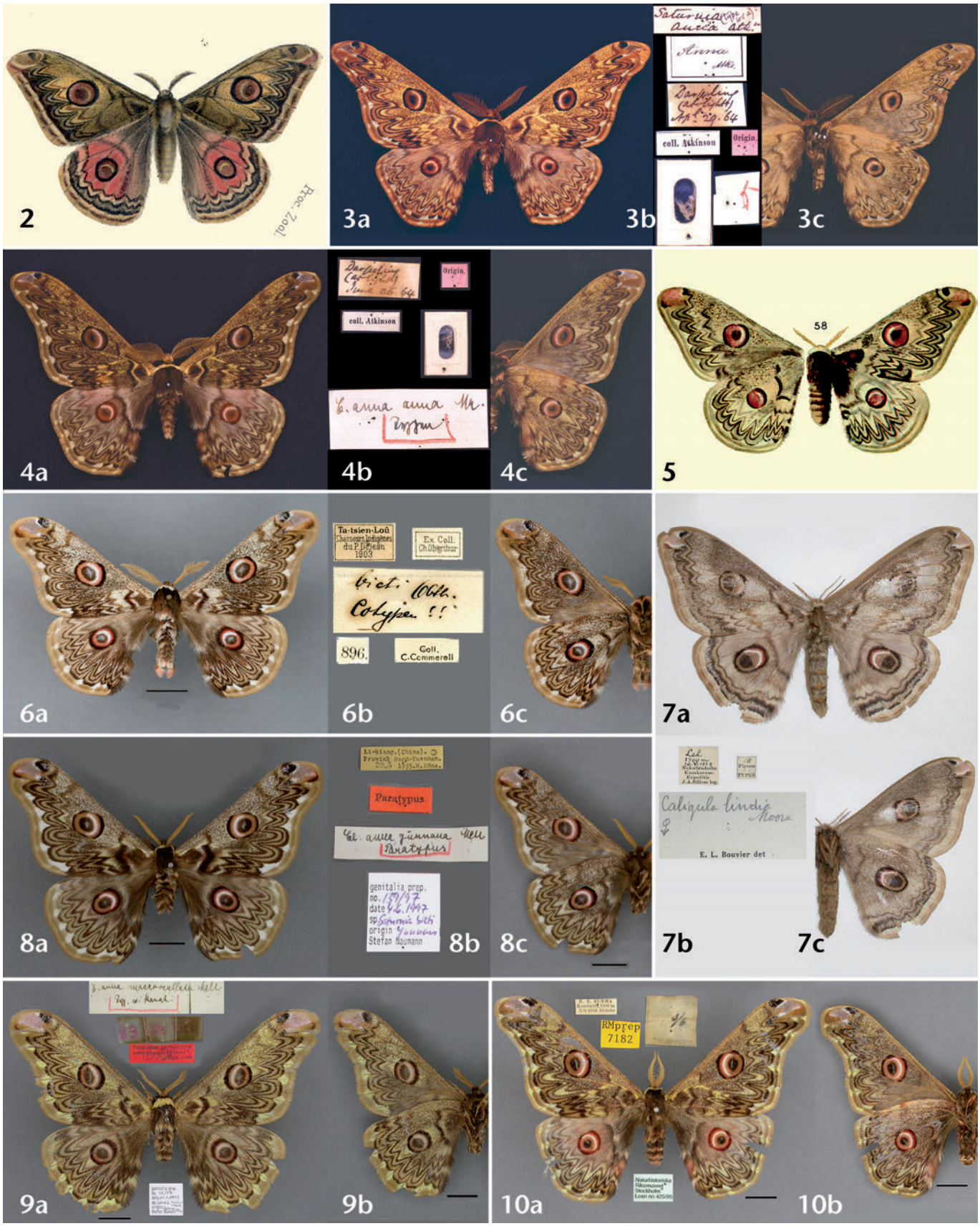

Plate 1: *Saturnia* type material and other singletons. **Fig. 2:** *Saturnia grotei,* picture taken from the original description in Moore (1859: Annulosa pl. LXV, fig. 2), turned to upright position. **Fig. 3:** *Saturnia anna,* LT ♂, ZMHU; **a:** ups., **b:** labels, **c:** uns. **Fig. 4:** *Saturnia anna,* PLT ♂, ZMHU; **a:** ups., **b:** labels, **c:** uns. **Fig. 5:** *Saturnia bieti* ♀, picture taken from the original description in Oberthür (1886: pl. 7, fig. 58). **Fig. 6:** *Caligula anna dejeani,* NT ♂, SMFL; **a:** ups., **b:** labels, **c:** uns. **Fig. 7:** *Caligula lindia sillemi* Bouvier, 1936, HT ♀; **a:** ups., **b:** labels, **c:** uns. **Fig. 8:** *Caligula anna yunnana,* PLT ♂, ZFMK; **a:** ups., **b:** labels, **c:** uns. **Fig. 9:** *Caligula anna tsinlingshanis,* LT ♂, ZFMK (labelled by Mell as ‡*macroocellata,* an unpublished manuscript name); **a:** ups. + labels, **b:** uns. **Fig. 10:** *Caligula anna diversa,* topotypical ♂, NRSS; **a:** ups. + labels, **b:** uns. — Photos S.N., except Fig. 2 & 6 (W.A.N.). — Pictures not to the same scale. Scale bar (where present) = 1 cm. Labels not always to the same scale (very large labels slightly reduced).

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will be added. The specimen is not a PT of *S. bieti* (as might be indicated by the "cotype" label), because the specimen was collected much later than Oberthür's description was published. However, this label shows that someone (possibly Oberthür?) identified the specimen correctly as a *bieti* specimen. Thus the NT designation stabilizes the current taxonomic usage by reliably synonymising the formerly instable name *dejeani* with the well-established taxon *bieti*.

Notes. The formal description of the taxon was published twice, first in the series "*Rapports*" (Bouvier & Riel 1931a), and then again in the "*Essais*" (Bouvier & Riel 1931b), both edited and published by the *Laboratoire d'Études de la Soie* in Lyon. The latter is an identical copy of the first, and in the present case also shows the same pagination for this article. Formally, the secondary description in the "Essais" created a junior primary homonym, for which of course no replacement name is neccessary due to objective synonymy (ICZN 1999). — This second publication was dispersed in separates (containing only this single article) in a separate cover which read "Extrait des *Annales du Laboratoire d'Études de la Soie* **17,** 1924–1931". However, such a third publication series "*Annales*" in fact never existed; it cannot be found deposited in any library. These separates (with the incorrect serial affiliation "*Annales*") were then used in 1977 to produce a facsimile reprint edition (Bouvier & Riel 1977 [reprint edition]), which was (and probably still is) available from booksellers and recently resulted in a few incorrect citations in literature, because the original series "*Rapports*" and "*Essais*" are rarely found in libraries.

8. *sillemi* Bouvier, 1936 [*nec* 1935]

Caligula lindia "ab." [= forma] ‡*sillemi* Bouvier, 1935(: 371, pl. I, fig. 18). Unavailable name [infrasubspecific] (ICZN 1999: Art. 45.6.2). (No type specimen for infrasubspecific names.)

Caligula lindia sillemi Bouvier, 1936(: 212 [key], 214); secondary validisation of the unavailable name ‡*sillemi* Bouvier, 1935. HT by monotypy and by indication: ♀, Ladakh, Karakorum, Leh, 3700 m, 30. v. 1929, leg. J. A. Sillem (ZMA) [i.e., the original specimen which gave rise to the unavailable infrasubspecific name ‡*sillemi* Bouvier, 1935]; see Fig. 7.

See further comments and explanations below in the revision under *Saturnia lindia*.

9. *yunnana* Mell, 1939

Caligula anna yunnana Mell (1939: 148). — LT ♂ **by present designation;** ZFMK [examined] (Fig. 8: a PLT illustrated). — L.t.: China, NW Yunnan, Likiang [= Lijiang Naxizu Zizhixian], 26. v.–21. vi. 1935.

Type material. Mell described this taxon after 8 ♂♂ in coll. Höne of which 7 specimens are deposited in ZFMK (examined), without designating a HT. In the Mell collection, deposited in ZMHU, there is a drawer in which a label "*anna yunnana* Mell Typus" and two empty stick-in places (with pin holes) lacking the specimens were found. Nothing could be found out about the whereabouts of these 2 specimens and whether they at any time where deposited in ZMHU or how they came back to ZFMK. A further ♂, the 8th ST specimen, is deposited in BMNH with data: "Likiang (China). Provinz Nord-Yuennan, 28. v. 1935, H. Höne" and "*C. anna yunnana* Mell" [handwritten by Mell] (examined). One ♂ specimen from the ST series in ZFMK with the labels "Li-Kiang. (China). Provinz Nord-Yuennan, 5. vi. 1935, H. Höne" and "*C. anna yunnana* Mell Typ. o. Parat." [handwritten Mell] plus affixed dried genitalia preparation is **herewith designated as lectotype,** the other ♂♂ in ZFMK and the single ♂ in BMNH thereby become PLTs (one ♂ PLT figured in Fig. 8). 2 of the PLTs in ZFMK have additional paratype labels or markings. Labels which will fix LT or PLT status will be added accordingly.

10. *tsinlingshanis* Mell, 1939

Caligula anna tsinlingshanis Mell (1939: 148). — Fig. 9: LT ♂ **by present designation;** ZFMK [examined]. — L.t.: China, "Taipeishan im Tsinlingshan" [= Shaanxi, Qingling mountains, Taibai Shan], [code "L" =]1700–3000 m, 19. vi.–2. vii. 1935.

Type material. This taxon was described by Mell after 11 ♂♂ and 2 ♀♀ of which most specimens are deposited via coll. Höne in ZFMK (examined). Again no specimens could be found in the drawer of the Mell collection in ZMHU. Some specimens have name labels "*C. anna* ‡*macroocellata* Mell" [handwritten, Mell]. This is obviously an unavailable manuscript name of Mell which never was published; Mell changed his mind about a name between writing labels and publishing the new taxon more often than this one time. A 12th specimen with identical label data "Tapaishan im Tsinling, Sued-Shensi (China, 22. vi. 1935 H. Höne" [red] was found in BMNH (examined). The 13th ST so far could not be located. A ♂ specimen (Fig. 9) with the labels "Tapaishan im Tsinling, Sued-Shensi (China), 23. vi. 1935 H. Höne" [red], "23. vi. 1935" [part of the original paper envelope of the specimen], and "*C. anna macroocellata* Mell Typ. o. Parat." [handwritten, Mell] is **hereby designated** as **lectotype,** the remaining material with more or less the same labelling (1 ♂ has a label "Paratypus" [red] and "*Cal. anna tsinlingshanis* Mell Paratypus" [handwritten, Mell]) automatically become PLTs; the labels will be added accordingly.

Note. There is a ♀ specimen in ETHZ (Fig. 47a) labelled as "Type" of an unavailable taxon "‡*tsinlingshani* [sic] O. Bang-Haas", which obviously never was published by O. Bang-Haas. The specimen was received by him on "2. ix. [19]31", i.e. earlier than the types of *tsinlingshanis* Mell. It belongs to *tsinlingshanis* Mell. We do not know whether this specimen was known to Mell when working on Höne's Taibaishan specimens.

11. *diversa* Bryk, 1944

Caligula anna diversa Bryk (1944: 15; pl. III, fig. 21 HT). — HT ♂ by original designation; NRSS [topotypical specimens examined]. — L.t.: [Myanmar], NE Burma [at the Yunnan border, ca. 10 km W Jiangao Shan], Kambaiti, 2000 m, 2.–8. iv. 1934.

Type material. This taxon was described by Bryk after only 3 ♂♂, of which the HT (by original designation) with data "N.E. Burma, Kambaiti, 7000 ft., 2.–8. iv. 1934, R. Malaise" is stated to be deposited in NRSS; 2 PTs with same data are also stated to be in NRSS. We have examined one specimen from NRSS with data "NE Burma, Kambaiti, 1800 m, 3. vi. 1934, Malaise" (Fig. 10), which was sent to us on loan as being a PT. A further series of 7 ♂♂ from the type locality, also collected by R. Malaise, is deposited in BMNH. All these were collected in vi. 1934 and therefore are no type material; this was collected in April only, according to Bryk's description.

Nomenclatural note. In the web (NRSS 2010), this taxon (and a few other taxa described in the same publication) is cited with the date "1943", probably based on the submission date printed on the first page of the contribution. However, in the original publication (Bryk 1944: 55), there is an imprint date of "31. i. 1944", and so the publication date clearly is 1944 (31. i.) (ICZN 1999: Art. 21.1, 21.2).

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Revisional notes on the *grotei*-group

Collecting expeditions (by V. Siniaev, in part mediated by A. Schintlmeister, by R. Brechlin and by others) in northern Vietnam mainly in the early and mid-1990s resulted in many specimens of a saturniid moth belonging to the *anna*-complex, which at first glance apparently diverged from the members of the complex from the Himalaya; its presence in Vietnam was already indicated by de Joannis (1928–1930). These specimens thus originally initiated the present study. At that early time we intended to describe this population as a new taxon (species or subspecies) within the *anna*-complex. However, later received additional, newly collected material of this complex from Tibet, Yunnan, Sichuan and other localities in China, as well as from Myanmar and other areas, further complicated the picture and made us come to the decision not to describe a new species or subspecies in the early 2000s. Now, with the results of mtDNA-COI barcode studies before us, we again altered this view.

We took the opportunity to study the different populations of the entire *grotei*-group based on relatively large numbers of recently collected specimens, including study of the type material, mainly based on external morphology and ♂ genitalia (♀ genitalia have generally not yet been studied; in *Saturnia s. l.* they are usually even more similar between species than the ♂ genitalia), plus mtDNA barcodes of especially new material, and the status of the taxa is discussed in the following.

Formally, all species of the *grotei*-group should (in accordance with Nässig 1994a) be classified as belonging to the genus *Saturnia,* subgenus *Rinaca*. However, as the subgeneric classification of the genus *Saturnia* requires further studies, we prefer to provisionally list all species here as members of the genus *Saturnia,* without applying a subgenus name (although the *grotei*-group still fits in *Rinaca* quite well). A revision of the internal classification of the genus *Saturnia* is planned for the near future.

The beautiful colouration of some of the species in contrasting greenish or yellowish and reddish colours is based on some sort of additive "pixel mixture"; there are no pure green colours in the scales (as usual in Saturniidae), but only some type of olive brown; the vivid green color is a mixture of yellow and blackish scales, sometimes with just some olive scales mixed in between.

We here count 11 species within the *grotei*-group, subdivided into two species complexes:

A) The species-complex of *Saturnia grotei*

Originally (see, e.g., Brechlin 2001, 2004) we considered the *grotei*-complex to consist of 5 species: *S. grotei, S. bonita, S. lindia, S. kitchingi* and also the later described *S. nanlingensis*. However, the results of the mtDNA COI barcoding analyses (see Fig. 1) indicated that

1. *S. kitchingi* and *S. nanlingensis* do evidently not at all belong to the *grotei*-group (their closest relationship appears to be in the *boisduvalii*-group of *Saturnia,* well separated from the *grotei*-group), and
2. there are, on the other side, obviously 2 more cryptic, so far undescribed species in the *grotei*-complex than only the 3 taxa *S. grotei, S. bonita* and *S. lindia,* so that the *grotei*-complex of the *grotei*-group nevertheless comprises 5 (in part cryptic) species now.

These are compared and described here.

Saturnia grotei Moore, 1859

Saturnia grotei Moore (1859: 265; Annulosa pl. LXV, fig. 2). – LT ♂ (designated above); BMNH (examined). – L.t.: [N-India, West Bengal], "Darjeeling".

Here illustrated: Figs. 2, 11–13; GP1: 1; Maps 1–2.

Cited in literature as:

Saturnia grotei: Moore (1859: 265; 1866: 818); Butler (1881: 61, pl. XCIV, fig. 3 ♂, fig. 4 ♀); Oberthür (1886: 31); Kirby (1892: 772); Hampson (1893: 18).

Saturnia (Rinaca) grotei: Nässig (1994a: 257).

Caligula grotei: Jordan (1911: 218); Seitz (1928: 516); Bouvier (1936: 212, 214); D'Abrera (1998: 34, 35, fig. ♂, ♀).

Distribution (Maps 1 & 2): **India: West Bengal:** Darjeeling (BMNH, CWAN in SMFL [Himafalls 2000 m, Tiger Hill 2400 m, leg. W. Thomas], ZMHU). Teesta Valley [27°4′2″ N, 88°25′49″ E, 300 m] (ZMHU). – **Sikkim** (BMNH, MHNL, ZSM).

S. grotei is obviously restricted to a very small area in Sikkim and northern West Bengal, India.

Hampson (1893: 23) mentioned the species also to be found in Simla [= Shimla, Himachal Pradesh, India] and "Tibet". Thus far we could not locate any specimens of that origin in museum collections; we believe these records (especially that from Shimla) might have been based on misidentifications. A locality west of Nepal would probably represent *S. paragrotei* described below.

Diagnosis: Before the present publication, *S. grotei* was unmistakable; now, with *S. paragrotei* sp. n. being described below, this has changed. D'Abrera (1998: 34) declared *S. grotei* to be probably one of the most beautiful saturniids, and he may be true. The species is characterized by its greyish brown fw. with undulate postdiscal lines and the intensive pink basal and median part of the hw., in combination with large fw. and hw. ocelli. For a differential diagnosis, see under *S. paragrotei* below.

Description: ♂ (Figs. 2, 11): Ground colour dark brown, suffused with yellow and black scales. Antennae dark brown, quadripectinate, with ca. 26 segments, longest rami 2.1 mm, total length 10 mm (measured in a ♂ from Sikkim on loan ex ZSM). Legs on the tibia with long pink hair, abdomen with lighter and darker brown rings on each segment, and ochreous anal tuft. Lfw. 36 mm, with round apex which bears a white, bent longitudinal line. Fw. ocellus with around 8 mm maximal diameter. Hw. in the basal and median area (except of the parts around the anal margin) of vivid pink colour, bordered with two dark wavy postdiscal lines. Hw. ocellus with ca. 6 mm maximal diameter. Submarginal line of both fw. and hw. from basal to marginal in black, ochreous, brown with interruptions at the crossing veins, and again ochre. Colour on ventral side similar, a little lighter, the pink portion of the hw. is completely lacking, and with less undulated postdiscal lines. There are only a few ♂♂ known, so the variability range cannot be reliably assessed.

♂ genitalia (Fig. GP1: 1): Uncus ventrally furcate, lateral processi bent to lateral side, the saccus quite reduced, short. The dorsal process of the valves rounded, with lots of small bristles, the

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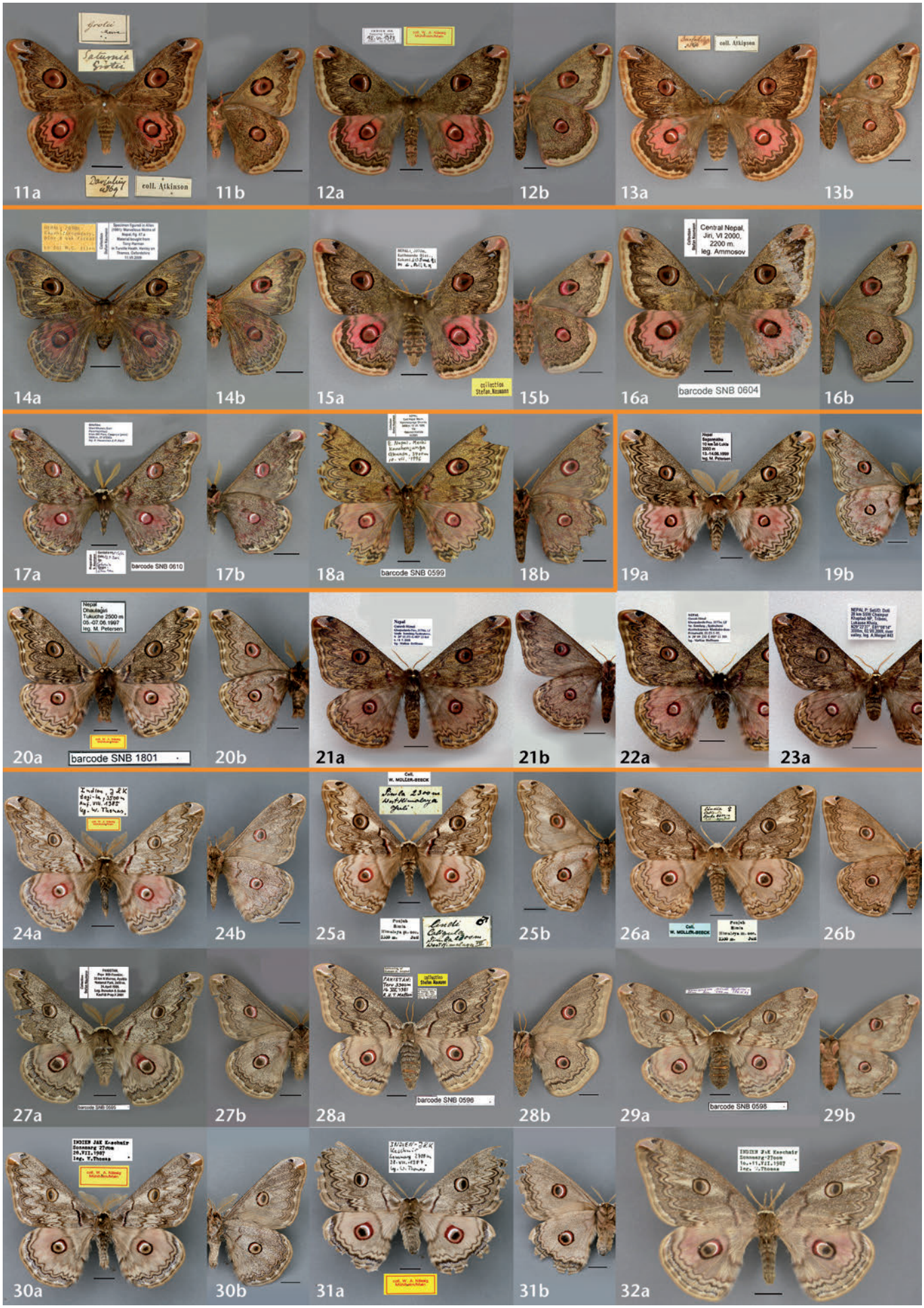

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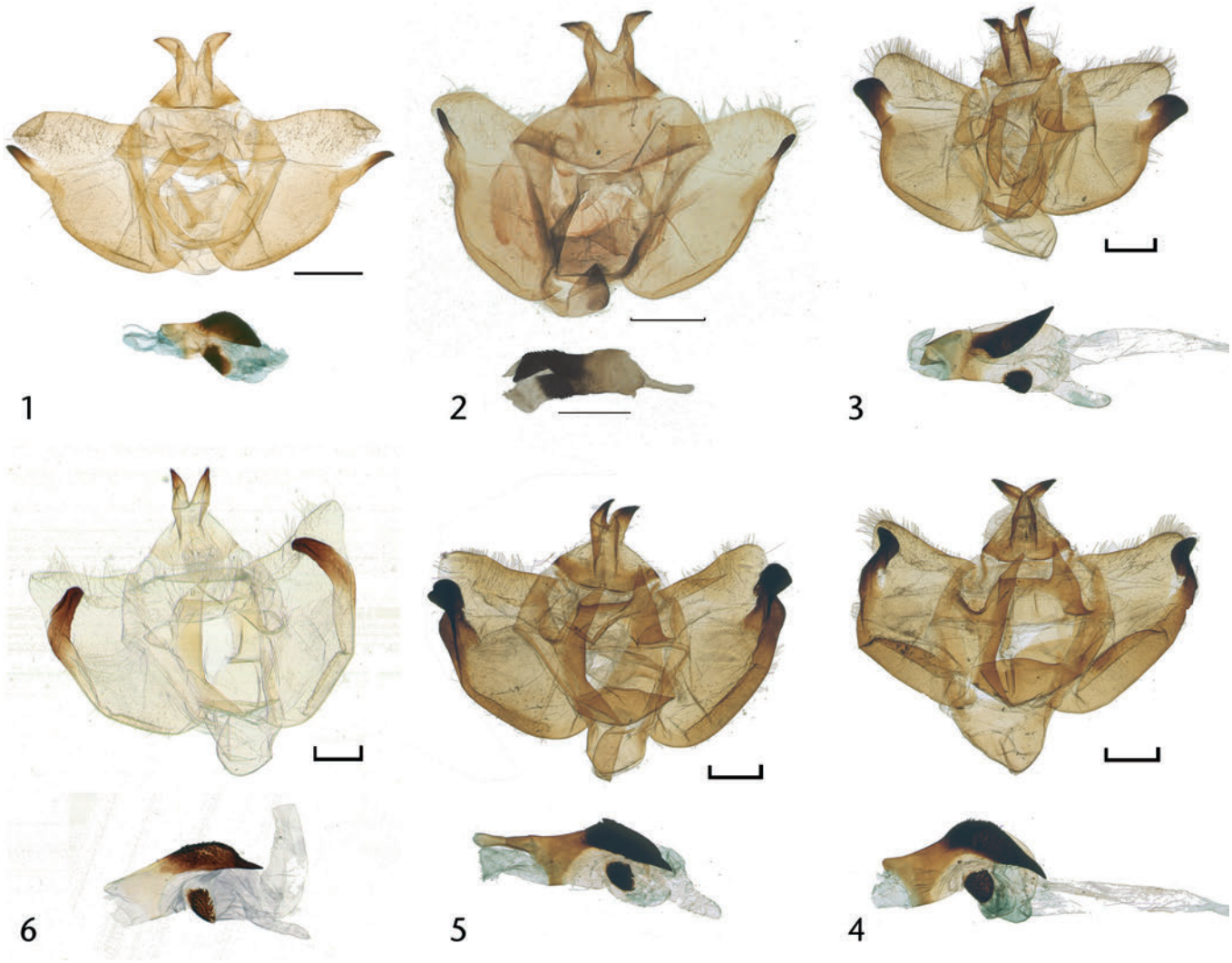

Genitalia plate 1: ♂ genitalia of *Saturnia* spp., species of the *grotei*-complex. **Fig. 1:** *Saturnia grotei,* Sikkim, MHNL, SNB 1545/05. **Fig. 2:** *S. paragrotei,* Nepal, SNB 2214/10. **Fig. 3:** *S. lindia,* Pakistan, SNB 1839/08. **Fig. 4:** *S. lindia,* Jammu & Kashmir, SNB 1840/08. **Fig. 5:** *S. rosalata,* Nepal, SNB 1841/08. **Fig. 6:** *S. bonita,* Bhutan, SNB 1451/06. — Not to the same scale; scale bars = 1 mm.

Plate 2: *Saturnia* specimens. Orange lines separating species. **Figs. 11–13:** ***Saturnia grotei.*** **Fig. 11:** ♂, [India, West Bengal], Darjeeling, ex coll. Atkinson, ZMHU. **Fig. 12:** ♀, India, West Bengal, Darjeeling, Tigerhill, 2400 m, 15. VI. 1989, leg. S. Tamang, via W. Thomas, CWAN in SMFL. **Fig. 13:** ♀, [India, West Bengal], Darjeeling, ex coll. Atkinson, ZMHU. — **Figs. 14–16:** ***S. paragrotei.*** **Fig. 14:** HT ♂, Nepal, 2070 m, Kakani, in CSNB, assigned to ZMHU. **Fig. 15:** PT ♀, same locality, CSNB. **Fig. 16:** PT ♀, Nepal, Jiri, CSNB. — **Figs. 17–18:** ***S. bonita.*** **Fig. 17:** ♂, Bhutan, CAHS. **Fig. 18:** ♀, Nepal, Kanchenjunga, CSNB. — **Figs. 19–23:** ***S. rosalata.*** **Fig. 19:** HT ♂, Nepal, 10 km SE Lukla, in CWAN in SMFL. **Fig. 20:** PT ♂, Nepal, Tukuche, leg. M. Petersen, in CWAN in SMFL. **Fig. 21:** PT ♀, Nepal, Ganesh Himal, leg. M. Hoffmann, CSLL. **Fig. 22a:** PT ♀, Nepal, Ganesh Himal, leg. M. Hoffmann, CSLL. **Fig. 23a:** PT ♀, Nepal, Seti, Khaptad-NP, leg. A. Weigel, CSLL. — **Figs. 24–32:** ***S. lindia***. **Fig. 24:** ♂, India, J&K, Zogi-La, leg. W. Thomas, in CWAN in SMFL; colourful form similar to *S. rosalata/bonita*. **Fig. 25–26:** India, [Punjab,] S[h]imla, ex coll. Müller-Beeck in SMFL; **Fig. 25:** ♂; **Fig. 26:** ♀. **Fig. 27:** ♂, Pakistan, NW-Frontier, Ayubia N.P., leg. Benedek & Szabó, CSNB. **Fig. 28:** ♀, Pakistan, Teru, leg. R. Mattoni, via coll. R. S. Peigler in CSNB. **Fig. 29:** ♀, Afghanistan, Samangan, CSNB. **Figs. 30–32:** India, J&K, Sonamarg, leg. W. Thomas; **Fig. 30:** ♂, CWAN in SMFL; **Fig. 31:** ♀, CWAN in SMFL; **Fig. 32:** dark ♀, CSNB. — **a** = ups., **b** = uns. — Photos S.N., except Figs.: 12, 19, 20, 24–26, 30–31 (W.A.N.); 21–23 (S. Löffler). — Pictures not to the same scale. Scale bar = 1 cm. Labels not always to the same scale (large labels often slightly reduced).

ventral process with long, heavily sclerotized almost straight thorn. The juxta bears two lateral long and tall processes. Phallus short, with a right dorsolateral dentate thorn and a large sclerite left lateral on the vesica which are both shorter and less sclerotiszed than in *S. paragrotei*.

♀ (Figs. 12–13): Quite similar to the ♂♂, of same colour, with typical sexually dimorphic characters, such as different antennae and more rounded, compact wings. Antennae bipectinate, with ca. 24–27 segments, longest rami ca. 1 mm, length in total 9 mm. Tibiae with pinkish hair. Lfw. 44/42 mm (n = 2), with rounded fw. apex. Fw. ocellus relatively small for the group, with 8–9 mm maximal diameter, hw. ocellus 6–7 mm.

Ecological observations: Not much is known about the ecology of the species. ♂♂ are most likely diurnal fliers which explains their dark antennae and relatively small eyes, and their rareness in collections, compared to ♀♀. When there is sexual dimorphism in eye size in bombycoid moths with sexes flying at different times (i.e., one sex at daytime, the other at night), the diurnal sex has generally smaller eyes than its nocturnal partner (see

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Tab. 1; compare Nässig & Czipka 1994, Nässig 2000, Nässig & Schulze 2007), and antennae of the diurnal sex have a tendency to be darker than that of the nocturnal one (see, e.g., Brechlin 2001, Wolfe 2005).

Tab. 1: Eye sizes of ♂♂ and ♀♀ of *Saturnia* species of the *grotei*-complex and *S. kitchingi*. Height: maximal diameter in dorso-ventral direction measured under a binocular. Width measured vertically to height, again maximal diameter. — Diurnal ♂♂ (*S. grotei, S. kitchingi;* a *S. paragrotei* ♂ was not available for measuring) have smaller eyes than nocturnal ones (*S. rosalata, S. lindia*). As the eyes are very similar in size for ♂♂ and ♀♀, ♀♀ of *S. kitchingi* may possibly also be diurnal[?]. (Always *n* = 1. Some specimens have not allowed for eye measuring without destroying set legs. * = small specimen.)

Eye sizes [in mm]				
Taxon	♂♂		♀♀	
	Height	**Width**	**Height**	**Width**
Saturnia grotei	1.3	1	1.8	1.4
Saturnia paragrotei	—	—	1.4*	1.1*
Saturnia rosalata	2.1	1.6	—	—
Saturnia lindia	1.95	1.56	2.1	1.8
Saturnia kitchingi	1.3	0.9	1.3	1

Both species, *S. grotei* and *S. paragrotei,* are known only from very restricted areas in the Himalaya (*S. grotei* only from Sikkim and northern West Bengal, India, and *S. paragrotei* only from a few central and eastern provinces in Nepal) and obviously are strictly allopatric (and possibly rather widely separated). Such small areas for mountain species are not rarely found, but it is remarkable in comparison with other species of the group.

Preimaginal instars: Thus far unknown.

Saturnia paragrotei sp. n.

HT ♂ (Fig. 14): Nepal, 2070 m, Kakani, secondary, pine & oak forest, Lt.Col. M. G. Allen [no date]; specimen figured in Allen (1991: fig. 47.a) [locality in Bagmati Prov. near Kathmandu]. Material bought from Tony Harman in Turville Heath, Henley on Thames, Oxfordshire, 11. vii. 2009; GP 2214/10 Naumann (in CSNB); assigned to ZMHU.

PTs (11 ♀♀), all from **Nepal:** 1 ♀, Kakani [Bagmati Prov.], 2070 m, 23. viii. 1990, native coll., bought from T. Harman (CSNB). 2 ♀♀, same locality, 10. vi. 1991, [leg.] M. G. Allen (CSNB) (Fig. 15). 1 ♀, Kathmandu Dist., Kakani, 2070 m, 1. vi. 1992, [leg.] M. G. Allen (CSNB). 1 ♀, Kakani, 2070 m, 16. viii. 1993, [leg.] T. W. Harman (CSNB). 1 ♀, Kakani, 2070 m, 6.–8. viii. 1990, T. W. Harman [leg], ex CSNB (CSLL). 1 ♀, Kathmandu Dist., Kakani Mt., 2100 m, LF 19. vii. 1996, leg. Max McColgan, BC SNB 0603 (CSNB). 1 ♀, Mount Everest District [Sagarmatha Prov.], 2900 m, 25. viii.–20. ix. 1999, leg. V. Gurko, bought xi. 1999, BC SNB 0602 (CSNB). 1 ♀, Central [Janakpur Prov.], Jiri, vi. 2000, 2200 m, leg. Ammosov, BC SNB 0604 (CSNB) (Fig. 16). 1 ♀, Phulchoki, Godavari, 18. vi. 1991, leg. M. Allen, via J.-M. Cadiou (CWAN in SMFL). 1 ♀, Ganesh Himal, Gholjong, 2400 m, 7. vii. 1998, leg. M. Petersen (CWAN in SMFL, BC B3220-wn-D12).

Type labels will be added accordingly.

Here illustrated: Figs. 14–16; GP1: 2; Maps 1–2.

Derivatio nominis: Named after the great external similarity to *S. grotei*.

Cited in literature as:

Caligula grotei: Haruta (1992: 94; pl. 25, fig. 7; 1994: 159); Allen (1993: 64, figs. 47.a ♂, b ♀); Smith (2001: 40).

Saturnia (Rinaca) grotei [partim]: Brechlin (2004: 41, figs. 11 & 12 ♀♀).

Distribution (Maps 1 & 2): So far only known from a restricted area in central and eastern **Nepal:** Bagmati, Janakpur and Sagarmartha Provinces. A few further records in literature (Haruta 1992, 1994, Allen 1993, Brechlin 2004, from more or less the same areas) are not plotted on the maps because these specimens were not examined by us; most likely all these are of the new species.

Diagnosis: Externally very similar to *S. grotei* (and next to indistinguishable), but differences in ♂ genitalia and the results of the barcode studies revealed the separate status of the Nepalese population. Besides the locality (*S. grotei:* N. India: Sikkim, northern West Bengal; *S. paragrotei:* eastern central Nepal), it is mainly the ♂ genitalia which are slightly different: *S. grotei* has slightly smaller and more delicate ♂ genitalia; the shape of the valves in *S. grotei* is — at approximally the same length — lower than in *S. paragrotei;* the uncus is slightly more elongate in *S. paragrotei,* and the phallus sclerites are slightly smaller in *S. grotei*. The white line found in the fw. apex of *S. grotei* may be less clearly developed in *S. paragrotei,* but not always. A morphological differentiation of the two taxa is not always possible.

Description: ♂ (Fig. 14): Almost all colour and pattern details are very similar to those of *S. grotei*. Because the only known ♂ of the species is the HT, there cannot said much about variation. Antennae also dark brown, quadripectinate, with ca. 24 segments, longest rami 1.4 mm, length in total 9.8 mm. Legs on the tibia with long pink hair, abdomen similar to *S. grotei*. Lfw. 35 mm (HT), with round apex where the white longitudinal line is often only slightly indicated as a lighter violet shadow in *S. paragrotei*. Fw. ocellus 8 mm maximal diameter, hw. 6 mm maximal diameter.

♂ genitalia (Fig. GP1: 2): The uncus is deeper furcate, the saccus a little larger than in *S. grotei*. Juxta and valves are quite similar (except that the valve of *S. paragrotei* is slightly higher at the same length), and differences can also be found in the phallus: the dorsolateral dentate thorn on the right side and the large sclerite laterally on the left side are both larger and more sclerotized than in *S. grotei*.

♀ (Figs. 15–16): Very similar to the ♂♂, of the same colour, with typical sexually dimorphic characters, such as different antennae and more rounded, compact wings, and very similar to ♀♀ of *S. grotei*. Antennae bipectinate, with ca. 24 segments, longest rami 0.7 mm, length in total 9.5–10 mm. Tibiae with pinkish hair. Lfw. 36–45 mm, with round apex; the apical white line of *S. grotei* is often less clearly developed in ♀♀ of *S. paragrotei*. Fw. ocellus 8.5–10 mm maximal diameter, hw. ocellus 7–9 mm diameter.

Ecological observations: The ♂ appears to be diurnal, similar to *S. grotei*. All known specimens were collected in the period vi.–ix. at altitudes of 2070–2900 m; the label of the HT indicates that it was collected in a mixture of secondary, pine and oak forest.

Regarding the restricted distribution areas, see note above under *S. grotei*. *S. grotei* and *S. paragrotei* appear to be strictly allopatric.

Preimaginal instars: In vii. 1996 a ♀ was collected by Max McColgan which deposited ova already in Nepal; they were brought back to Berlin, but unfortunately the larvae hatched on the way back and died. No documentation of the preimaginal instars is presently available.

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Saturnia bonita (Jordan, 1911)

Caligula lindia bonita Jordan (1911: 218). – LT ♂ (designated by Brechlin 2001: figs. 13, 29); BMNH (examined). – L.t.: "Yatung [= Yadong], Tibet".

Here illustrated: Figs. 17–18, GP1: 6; PIP I: a–n, y; Maps 1–2.

Cited in literature as:

Caligula lindia bonita: Jordan (1911: 218); Bouvier & Riel (1931a: 47; 1931b: 47); Bouvier (1936: 212, 214); Nässig (1983: 98, fig. 5.l ♂); Zhu & Wang (1983: 412, pl. 134, fig. 2974; 1993: 281, fig. 20 ♂ genitalia; 1996: 137, fig. 103 ♂ genitalia); Wang (1988: 460); Xue & Wang (1989: 44 [partim]). – Xue & Wang (1989: 44) list "*Caligula lindia bonita*" from Tibet, Yadong, 3000 m (copied from Zhu & Wang 1983?) and Jiacha, 3260 m [misidentification?]; however, the specimen illustrated on their pl. IX, fig. 4, clearly shows *S. bieti* (see below).

Caligula lindia bonita Zordan [*sic*]: Zhu & Wang (1996: pl. VIII, fig. 3).

Saturnia (Rinaca) bonita: Nässig (1994a: 257); Brechlin (2001: 97, figs. 13 ♂, fig. 14 ♀, figs. 28 & 29 ♂ genitalia; 2004: 41).

Distribution (Maps 1 & 2):

Nepal: East (Sikkim border): Mechi Prov., Kanchenjunga, Ghunsa, 3400 m (CSNB).

India: Sikkim, Gnatong (Bouvier & Riel 1931a: 47); West Bengal, Shingahla N.P., Tongku, 3070 m (Brechlin 2001: 98).

China: Tibet, Yadong (BMNH, CMWM; Zhu & Wang 1983, 1993, 1996). – There might be further localities for *S. bonita* in Tibet, but there are also a lot of misidentifications in Chinese literature (see, e.g., under *S. bieti* or *S. sinanna* sp. n. below), and we have not seen the specimens responsible for the Chinese records in literature.

Bhutan: West, Paro Dzongkhag, Jhomolari-Trek, 3120–3610 m (CAHS, CSNB, SMNK); Chele La, 3800 m (CAHS).

Saturnia bonita is the eastern species of the subcomplex *lindia-rosalata-bonita,* from easternmost Nepal further eastwards to W. Bhutan.

Most likely all specimens listed under "*S. bonita*" from Nepal in Brechlin (2001: 97–98, not examined by us) belong in fact to *S. rosalata* sp. n. described below, as well as most of the western "*S. bonita*" records from Nepal in Brechlin (2009a: 50, not examined by us).

Diagnosis: A relatively small and somehow fragile species compared to its closest relatives, *S. lindia* and *S. rosalata* sp. n., described below, with a relatively falcate fw. apex in the ♂♂. It is generally of greyish black ground colour, and some specimens have a pink portion in the hw. median area.

Description: ♂ (Fig. 17): Ground colour more or less dark grey, suffused with white and black scales. Antennae ochreous, quadripectinate, with ca. 27 segments, longest rami 1.9 mm, total length ca. 11 mm. Legs on the tibia with long pinkish grey hair, abdomen dark grey with intersegmental white tufts, and light grey anal tuft. Lfw. 40 mm, with relatively falcate round apex. Fw. ocellus with around 7.5 mm maximal diameter. Basally 2 faint undulate postdiscal lines, only the marginal one more intensive, dark, submarginal line with a row of connected yellowish white triangles, followed marginally by a dark grey and ochreous margin. Hw. of some specimens in the basal and median area suffused with a touch of pink colour, bordered with two dark wavy postdiscal lines. Hw. ocellus with ca. 6 mm maximal diameter. Colour on ventral side similar, a little lighter, the pink portion of the hw. is completely lacking, and with less undulate postdiscal lines; there is a typical reddish grey median line on the hw.

♂ **genitalia** (Fig. GP1: 6): The uncus deeply furcate, lateral processi slender, with sclerotized acute tips, the saccus quite short and rounded. The dorsal (apical) process of the valves more acute than in related taxa, with some marginal bristles, the ventral process (harpe) long, heavily sclerotized, almost straight, acute. The juxta bears two lateral long and tall processes. Phallus with a right dorsolateral long and acute thorn and a large rounded sclerite left lateral.

♀ (Fig. 18): Similar to the ♂♂, of same colour, with typical sexually dimorphic characters, such as different antennae and more rounded, compact wings. Antennae bipectinate, with ca. 25 segments, longest rami 1.0 mm, length in total 11 mm. Tibiae with pinkish hairs. Lfw. ca. 46 mm, with rounded apex. Fw. ocellus 9.6 mm maximal diameter, hw. ocellus 7.5 mm.

Ecological observations: The species is a high altitude representative and occurs only in the rather small "four countries corner" of Yadong in Tibet, western Bhutan, eastern Nepal, and enclosed Indian northern parts of Sikkim and West Bengal. It was collected at altitudes from around 3000 to 3800 m. Lots of empty old cocoons were found in July 2005 by S.N. on the Jhomolari Trek, West Bhutan, in altitudes of around 3500 m (Fig. PIP I: a), on trunks of *Salix* sp. near to the ground, always on the mossy humid side of the tree (Fig. PIP I: d). Based on this observation, we believe that this tree (Fig. PIP I: y) is also the foodplant for *S. bonita* larvae in the wild, at least at this locality.

Preimaginal instars: The species was reared and documented photographically by R. Trusch and S.N. from Bhutan, Paro District, Jhomolari Trek (just about 50 km from the type locality; leg. A. Hauenstein, R. Trusch et al.) on *Salix caprea* and *Tilia* sp. in 2010 (see PIP I: Figs. a–n, y).

Description of the preimaginals: The L_1 larva is green, with some black pattern and black head. The mature larva of *S. bonita* is quite variable (intensity of black pattern), and the anal pattern is even more prominent than in *S. lindia*. For a comparison with *S. rosalata* and *S. lindia,* see illustrations on PIP I and Tab. 2.

Saturnia rosalata sp. n.

HT ♂ (Fig. 19): Nepal, Sagamartha, 10 km SE Lukla, 3500 m, 13.–14. vi. 1999, leg. M. Petersen, in (CWAN in) SMFL.

PTs (45 ♂♂, 6 ♀♀, Figs. 20–23), all **Nepal: Ganesh Himal (Bagmati):** 13 ♂♂, Khurpudanda-Pass, 2952 m, LF, Str. Somdang–Syabrubensi, Hemlocktannen-Rhododendron-Primärwald, 28° 9.544′ N, 85°14.245′ E, 18./19. v. 2007, leg. M. Hoffmann (CSLL). 1 ♂, 1 ♀, Khurpudanda-Pass, 3577 m, LF, Str. Somdang–Syabrubensi, Hemlocktannen-Rhododendron-Primärwald, 28°9.232′ N, 85°13.393′ E, 22./23. v. 2007, leg. M. Hoffmann (CSLL). 4 ♂♂, Khurpudanda-Pass, 3620 m, LF, Str. Somdang–Syabrubensi, Hemlocktannen-Rhododendron-Primärwald, 28°10.039′ N, 85° 12.693′ E, 23./24. v. 2007, leg. M. Hoffmann (CSLL). 2 ♂♂, Khurpudanda-Pass, 3591 m, LF, Str. Somdang–Syabrubensi, Hemlocktannen-Rhododendron-Primärwald, 28°5.342′ N, 85°12.751′ E, 10./11. vi. 2007, leg. M. Hoffmann (CSLL). 5 ♂♂, Khurpudanda-Pass, 3620 m, LF, Str. Somdang–Syabrubensi, Hemlocktannen-Rhododendron-Primärwald, 28° 10.039′ N, 85° 12.693′ E, 11./12. vi. 2007, leg. M. Hoffmann, GP 1841/08 Naumann, BC SNB 0600, ex CSLL (CSNB). 4 ♂♂, 1 ♀, same

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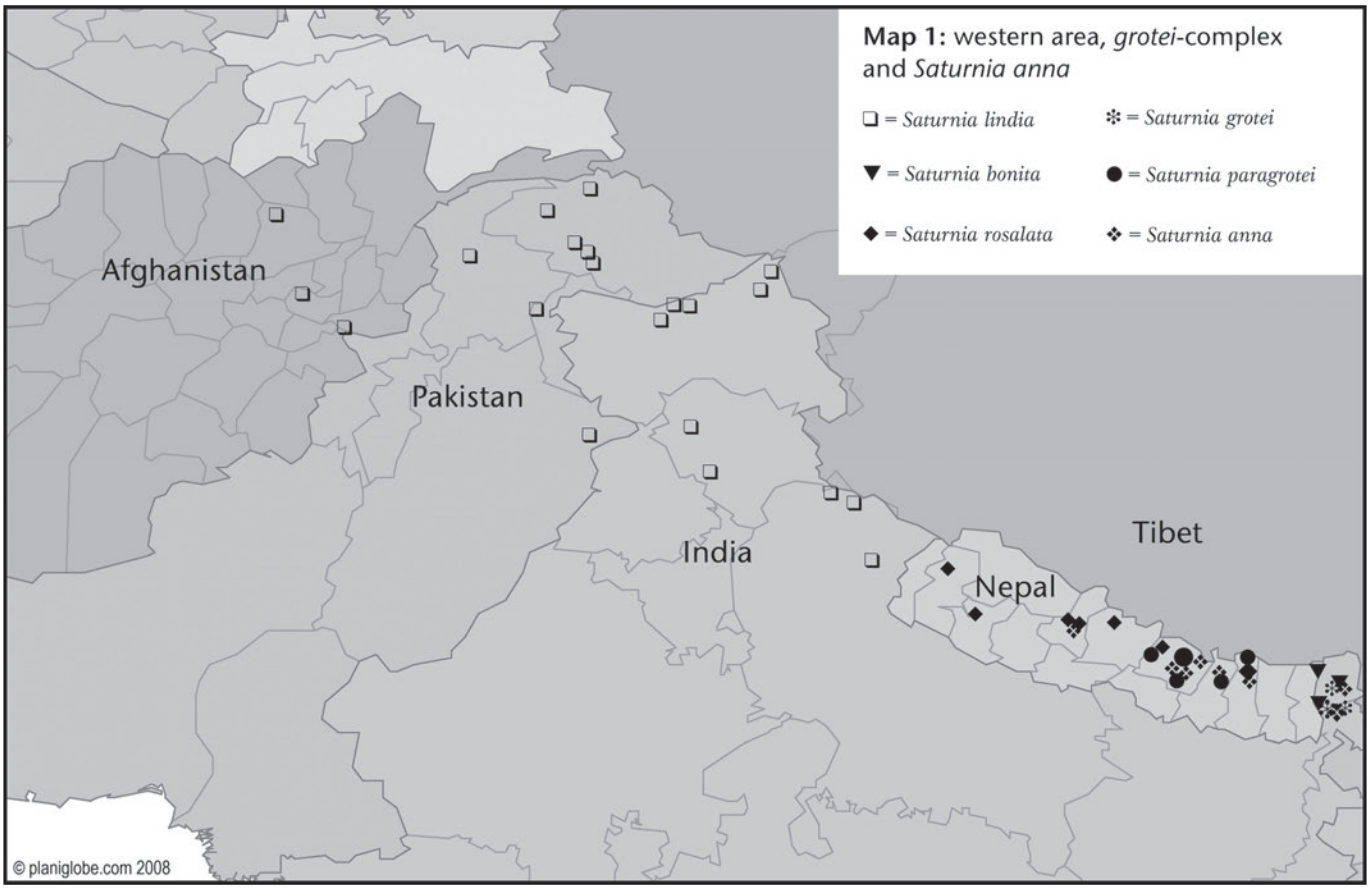


Map 1: Western area, species of the *grotei*-complex and *Saturnia anna* (especially for *S. anna* and other species of the *anna*-complex, see also Maps 2 & 3, central and eastern areas). — For all maps: Symbols slightly enlarged = type localities, including synonyms. One symbol may stand for more than one locality in close proximity. Not all localities listed in the text were located on maps. — All map bases from www.planiglobe.com, licensed under a Creative Commons Attribution 2.5 license and modified for use as distribution maps.

data (CSLL). 9 ♂♂, 1 ♀, Khurpudanda-Pass, 3179 m, LF, Strasse Somdang–Syabrubensi, 6.–8. VII. 2008, leg. M. Hoffmann (CSLL). — **Seti:** 3 ♀♀, District Doti, 20 km SSW Chainpur, Khaptad-N.P., Tribeni, Lukause Khola, river valley, 29°22′27″ N, 81°8′14″ E, 3000 m, 2. VII. 2009, leg. A. Weigel (CSLL). — **Bheri:** 1 ♂, 20 km N Dailekh, 3000 m, 29. IV. 1997, leg. M. Hreblay & L. Szécsényi, BC SNB 0601, ex CMWM via CSLL in CSNB. — **Annapurna Himal (Gandaki):** 1 ♂, 1 km W Hongde, 28°36′ N, 84°11′ E, 12. VI. 1996, 3450 m, leg. Hreblay & Szaboky (CSLL). 1 ♂, 2 km NW Kaisang [**Dhawlagiri**], 28°44′ N, 83°46′ E, 3900 m, 21. VI. 1996, leg. Hreblay & Szaboky (CSLL). 1 ♂, Mt. Kalinchok, 8 km NNE Muldi (Murree), 3100 m, 28. VI. 1997, leg. M. Hreblay & K. Csak (CSLL). — **Gandaki** [recte **Dhawlagiri**]: 1 ♂, Dhaulagiri, Tukuche, 2500 m, 5.–7. VI. 1997, leg. M. Petersen (CWAN in SMFL, BC SNB 1801). — **Central:** 1 ♂, Mt. Dhaulagiri NE, 3000 m, 3. VII. 1995, leg. E. Afonin & V. Siniaev (CSLL). — **Sagamartha:** 1 ♂, Solu Khumbu Himal, Lukla, 2800 m, 26. VI. 1993, leg. M. Hreblay & G. Csorba (CWAN in SMFL, GP Nässig 742/95).

Type labels will be added accordingly.

Further specimens (no PTs, not examined by us) see in Brechlin (2001: 97–98) — most likely all specimens listed there for Nepal belong to *S. rosalata* sp. n.

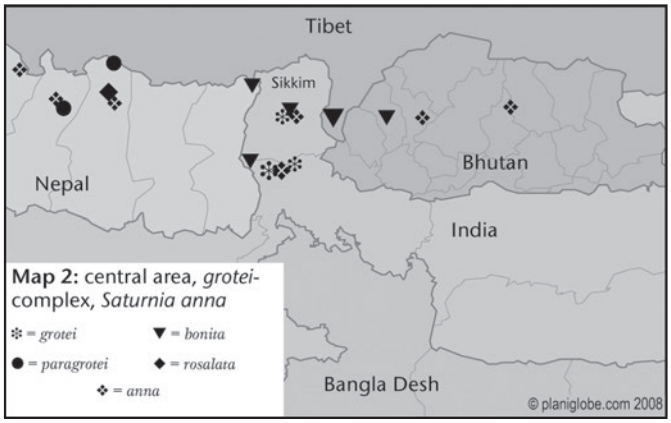
Here illustrated: Figs. 19–23; GP1: 5; PIP I: r–x; Maps 1–2.

Derivatio nominis: Named after the red hindwing colouration, usually more intensive than in the similar *S. bonita*.

Cited in literature as:

Caligula lindia: Haruta (1995: 89, pl. 104, figs. 1–2).

Saturnia (Rinaca) lindia: Kishida (1998: 40; his reference to "pl. 93: 6" is wrong, probably "pl. 104, figs. 1–2" was intended). — This record by Kishida (3 ♀♀) comes from the



Map 2: Central area, species of the *grotei*-complex and *Saturnia anna*.

Preimaginals plate I: Species-complex of *Saturnia grotei* plus *S. tsinlingshanis*. Orange lines separating species. **Figs. a–n:** ***Saturnia bonita,*** West-Bhutan, Provinz Paro, Jhomolari-Trek, N Shinkarap, S Takengthanka, "Thongdo", 27°39′54″ N, 89°15′55″ E, 3260 m, 11.–12. v. 2010 leg. A. Hauenstein, R. Trusch et al. (same locality also visited by S.N. in 2005). Reared in 2010 (v./vi./vii.) in Germany on *Salix caprea* and *Tilia* sp. by R. Trusch and S.N. Phot. 2010 R. Trusch, 2005 S.N. **Fig. a:** biotope (2005, S.N.). **Fig. b:** ♂. **Fig. c:** ♀. **Fig. d:** empty cocoon in the wild (2005, S.N.). **Fig. e:** L_1, 30. v. 2010. **Fig. f:** L_1, 30. v., more black pattern. **Fig. g:** L_2, 7. vi. **Fig. h:** L_3, 11. vi. **Figs. i–k:** L_4, 21. vi.; **i:** head, green; **j:** head, with black pattern; **k:** larva, lateral view. **Figs. l–n:** L_5; **l:** greenish morph; **m–n:** colourful morph. Photos: R. Trusch, Karlsruhe, if not indicated

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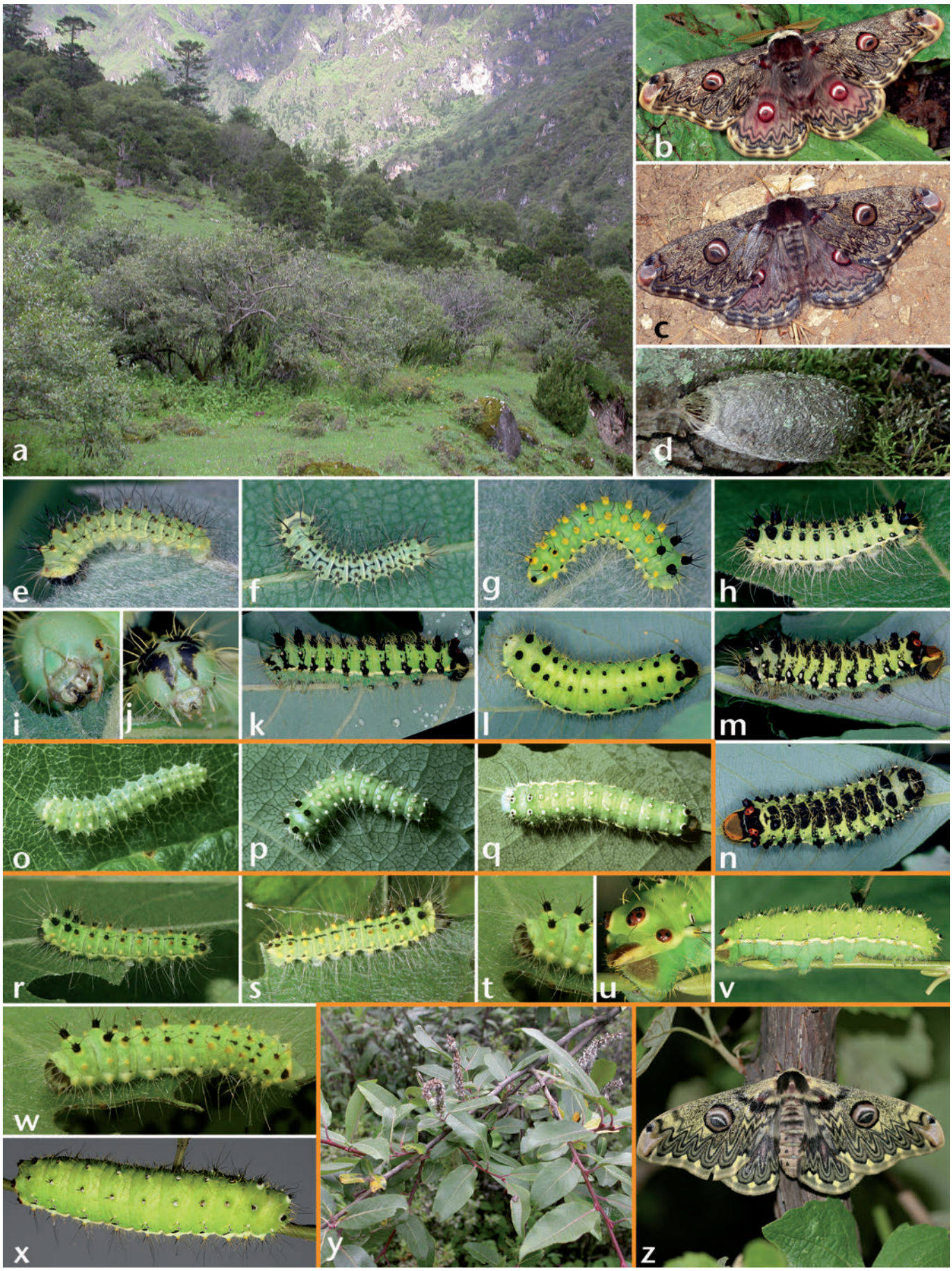

differently. — **Figs. o–q:** ***S. lindia,*** India, Jammu & Kashmir, Sonamarg; reared 1980–1982 in Germany by W.A.N. on *Corylus* etc. (see Nässig 1983). Phot. W.A.N. **Fig. o:** L_1. **Fig. p:** L_2. **Fig. q:** L_3. — **Figs. r–x:** ***S. rosalata,*** Nepal, Annapurna area, Tadapani. Reared and photographed by V. Siniaev. **Figs. r–t:** ca. $L_{2/3}$; **r:** green form; **s:** more black pattern; **t:** head (black). **Fig. u–v:** ca. L_5; **u:** anal end; **v:** larva, lateral view. **Fig. w:** ca. $L_{2/3}$. **Fig. x:** ca. L_5. Phot. V. Siniaev. — **Fig. y,** ***S. bonita:*** Bhutan, Provinz Paro, Jhomolari-Trek, 3260 m, *Salix* sp., probable foodplant of *S. bonita*. Phot. 2005 S.N. — **Fig. z,** ***S. tsinlingshanis:*** ♀ of the rearing, see PIP II, Fig. a. Phot. V. Siniaev.

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extreme northwestern part of Nepal (Prov. Mahakali: Kuntisong 29. VI. 1995, Raakang 30. VI. 1995). The reported specimens are not illustrated; so they might possibly belong to *S. lindia* instead of *S. rosalata* (therefore these places are not plotted on Map 1).

Saturnia (Rinaca) bonita [partim]: Brechlin (2001: 97–98).

Distribution (Maps 1 & 2): Known only from **Nepal:** Seti, Bheri, Dhaulagiri, Annapurna Himal, Gandaki, Ganesh Himal and Sagamartha provinces. The determination of exact geographical borderlines to *S. lindia* in the West and to *S. bonita* in the East (and whether they are allopatric or locally syntopic) requires further research.

Saturnia rosalata sp. n. is the middle species of the subcomplex *lindia-rosalata-bonita,* from Nepal. Its distribution area is smaller than that of *S. lindia,* but evidently larger than that of *S. bonita.*

Diagnosis: Relatively large and vividly coloured species. *S. rosalata* is characterized by a dark greyish fw. and (in most specimens) a typical pink hw., even on the ventral side, few specimens look faded, although being fresh. All ♂♂ have a quite falcate fw. apex; by all those details they easily can be separated from the closest relative, *S. bonita*, with which *S. rosalata* was confounded in all recent literature on the Nepalese fauna.

Description: ♂ (Figs. 19–20): Ground colour more or less dark grey, suffused with white and black scales. Antennae ochreous, quadripectinate, with ca. 26 segments, longest rami 2.6 mm, total length 14–18.5 mm. Legs with long pink hair on the tibia, abdomen dark grey with brown intersegmental tufts and pinkish grey anal tuft. Lfw. 42–50 mm (HT 49 mm), with relatively falcate round apex. Fw. ocellus with around 7–8 mm maximal diameter. Faint basal undulate postdiscal line, the two marginal ones more intensive, dark, submarginal line with a row of more or less connected yellowish-white triangles, followed marginally by a dark grey and olive margin. Hw. in the basal parts of the antemedian area black, medially pink, the complete median area of pink colour, bordered with two intensive dark wavy postdiscal lines. Hw. ocellus with 5.5–7 mm maximal diameter, marginal area as in fw. Colour on ventral side a little lighter, the pink portion of the hw. still very visible, and with less undulate postdiscal lines; there is a typical reddish-grey median line the hw. and a dark grey one on the fw. All wings show an overall pink shadow.

♂ genitalia (Fig. GP1: 6): Uncus deeply furcate, lateral processi slender, with heavier sclerotized acute tips than in *S. bonita*, saccus round. Dorsal process of the valves more rounded than in *S. bonita*, with some marginal bristles, the ventral process with long, heavily sclerotized rounded bilobed process. The juxta bears two lateral long and tall processes. Phallus with a right dorsolateral long and acute thorn which is broader and longer than in *S. bonita*, and a large rounded sclerite left lateral.

♀ (Figs. 21–23): Very similar to the ♂♂, of same colour, with typical sexually dimorphic characters, such as different antennae and more rounded, compact wings. Antennae bipectinate, length in total 10.7 mm. Tibiae with pinkish hair. Lfw. 45.5 mm (42–49 mm, *n* = 6 specimens in CSLL), with round apex. Fw. ocellus with 7 mm maximal diameter (6–9 mm), hw. ocellus with 5.8 mm (5–7 mm) diameter.

Ecological observations: Not much knowledge exists for this generally not rare taxon from central and western Nepal. According to the locality labels the imagines are on the wing from end of April to early July at altitudes of 2950–3900 m.

Preimaginal instars: The species was reared and documented photographically by V. Siniaev from Nepal, S. Annapurna area, Tadapani, in 2008 (see PIP I, Figs. r–v). The L_1 is not illustrated in V. Siniaev's photos. $L_{2/3}$ are green, with some more black pattern on body and head in comparison to *S. lindia,* especially black dorsal scoli along most of the body (in *S. lindia* only on the thorax); late instars less prominently coloured than *S. lindia* and *S. bonita*. See illustrations on PIP I and Tab. 2 for the comparison.

Saturnia lindia Moore, 1865

Saturnia lindia Moore (1865: 424, pl. XXII, fig. 3). – LT ♂ (designated by Brechlin 2001: fig. 9); BMNH (examined). – L.t.: „NE-India".

Here illustrated: Figs. 7, 24–32; PIP I: o–q; GP1: 3–4; Map 1.

= *Saturnia hockingii* Moore, 1888 (syn.) – *Saturnia hockingii* Moore (1888: 402). LT ♂ (designated by Brechlin 2001: fig. 11); BMNH (examined). – T.l.: „Kullu" [NW-Himalaya].

= *Caligula lindia* "ab." [= forma] ǂ*sillemi* Bouvier, 1935. – The name ǂ*sillemi* Bouvier (1935: 371, pl. 1, fig. 18) was published at invalid infrasubspecific rank [not available]. Nässig (1983, 1994), in fact, did not intend to raise the status of the taxon ǂ*sillemi* Bouvier, 1935 to a higher level, but due to some inconsistencies in the lines containing the information and a somewhat ambivalent wording and layout especially in the latter publication some readers interpreted this paragraph as being a status rise of ǂ*sillemi* to subspecific or specific level – which, however, was not formally indicated in the text. Consequently, but in fact unnecessarily, Brechlin (2001: 98) re-synonymised this invalid taxon with *lindia*. In the formal sense of the Code, this name ǂ*sillemi* Bouvier, 1935 was not validly rised to specific or subspecific status by Nässig, but already by Bouvier (1936: 212, 214), see next paragraph. – Original specimen (no type for ǂ*sillemi* Bouvier, 1935, because infrasubspecific names do not have types!) deposited in ZMA (examined), see Fig. 7.

= *Caligula lindia sillemi* Bouvier, 1936, **syn. n., comb. n.** Bouvier (1936) validated his unavailable name of 1935 a year later in the monographic book while listing the name as a subspecific name and referring to the publication a year before. He, in fact, was the only author who used the name *sillemi* validly at subspecific level. The HT (by monotypy and indication) of *sillemi* Bouvier, 1936 is the original specimen of ǂ*sillemi* Bouvier, 1935, deposited in ZMA, thereby also defining the l.t. This secondary validation of Bouvier's infrasubspecific name of 1935 was overlooked both by Nässig (1983, 1994a) and Brechlin (2001).

Cited in literature as:

Saturnia lindia: Moore (1865: 424, pl. XXII, fig. 3); Kirby (1892: 773); Hampson (1893: 23); Nässig (1994a); Weisz (1996 [unpubl.]: 55 *ff.*, pls. 7, 9); Lampe (2010: 360, pl. 290, larva, ♂, ♀).

Saturnia (Rinaca) lindia: Nässig (1994a: 257); Brechlin (2001: 96; 2004: 41).

Caligula lindia: Jordan (1911: 218, pl. 32b); Seitz (1928: 516); Bouvier & Riel (1931a: 47; 1931b: 47); Bouvier (1935: 371; 1936: 212, 214) Nässig (1983: 89 *ff.*, figs.); D'Abrera (1998: 36, 37, fig. ♂, ♀); Miranda & Peigler (2007: 436, fig. 7 larva).

Saturnia hockingii: Moore (1888: 402); Kirby (1892: 773).

Caligula lindia sillemi: Bouvier (1936: 212, 214).

Distribution (Map 1):

Afghanistan: N, Samangan, ca. 1500 m (CSNB). E, Paghman, 30 km NW Kabul, 2500 m (coll. Vartian in NHMW). S-Salangpaß,

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Tab. 2: Comparison of the known preimaginal instars of *Saturnia lindia, S. rosalata* and *S. bonita* (see colour plate PIP I). — L_n = larval instar no. — a*[n]* = abdominal segment no. *[n]*.

Character	*Satunia lindia* (PIP I: o–q; see also Näss1g 1983)	*Saturnia rosalata* (PIP I: r–x)	*Saturnia bonita* (PIP I: a–n, y)
L_1 larva	Totally green, with a few tiny black dots; scoli greenish white, head green.	Unknown [not photographed].	Larva green, with black scoli and black head.
$L_{2/3}$ larva	Head green. Scoli white, except the dorsal ones on meso- and metathorax and on a9 which are black, as well as anal plate and last pair of legs laterally.	Head green, often with blackish pattern. Scoli either black or (on the mid-abdominal segments) yellowish.	Larva green; head not visible on pictures. L_2 green with black dorsal (and some lateral) scoli and black pattern; L_3 green with black dorsal scoli on meso- and metathorax and [a8 +] a9, other dorsal scoli yellowish; black pattern on anal shield and anal legs.
L_4 larva	Head green. Similar to L_5.	Head black or green with black pattern[?, not well photographed].	Head green or green with black pattern. Larva green with black pattern, similar to L_5.
Mature larva (L_5)	Head green. Scoli white, except those on meso- and metathorax and [a1 +] a8 (with 2 black hair bases each); scoli on a9 part of the anal pattern. Contrast of anal scoli very prominent. Prominent anal scoli in larvae from Kashmir reddish, from Spiti valley orange coloured. Basolateral stripe bulgy, yellwish to white.	Head probably green [not well photographed]; body green, with black hair bases on scoli; scoli and basolateral stripe bulgy, prominently white. Dorsal scoli more or less all white with black hair bases and pattern; anal pattern less prominent than in *S. lindia* or *S. bonita*, anal plate and legs only brownish (not red), dorsal scoli on a9 much less contrasting.	Intensity of black pattern very variable, from green larvae with black scoli and black rings around spiracles to nearly black larvae with green pattern. Anal plate, scoli on a9 and anal legs with very prominent black and red pattern. Basolateral stripe white, but black pattern around spiracles interrupting the white.
Cocoon	Single-walled, free preformed exit of "Reuse" type (like a valve), wall without perforation, closed. Cocoon more or less pear-shaped, brown.	Unknown.	Like in *S. lindia,* but wall smoother, possibly more shining, and shape evidently narrower.
Pupa	Figured in Näss1g (1983: fig. 2).	Unknown.	Unknown.
Foodplant etc.	Polyphageous, found on *Hippophae,* reared on *Salix, Populus, Betula, Corylus, Tilia* etc.	Unknown in the wild.	Known from *Salix* sp.; reared on *Salix caprea* and *Tilia* sp.

N Kabul, 2700 m (coll. Vartian in NHMW). SO, Safed Koh southern slopes, Kotkai, 2350 m (coll. Vartian in NHMW; Ebert 2010).

Pakistan: NW Frontier: 35 km N Murree, Ayubia N.P., 2450 m (CSNB, CSLL). Ayubia, 2450 m (CSLL). Kaghan, Naran (CSNB). Kaghan, Shogran, 2300 m (CWAN in SMFL). — **Swat:** Madyan, ca. 35°23′ N, ca. 72°10′ E, 1400 m (coll. Vartian in NHMW). — **Gilgit:** Teru, 3300 m (CSNB). Naltar, 3000–3200 m (CWAN in SMFL). — **Kashmir:** 6 km NW Chilam Chauki, 3300 m, 35°8′ N, 74°59′ E (CSLL). 10 km SW Astor, Rama, 3000 m, 35°20′ N, 74°46′ E (CSLL). Karakorum, Fairy Meadows, near Rakiot Bridge, 3400 m, 35°22.886′ N, 74°34.693′ E (CSLL).

India: Himachal Pradesh: N. Manali, S. Rothang La, 2400–2800 m (CSLL). Manali, 2500 m (CSLL). Spiti valley, Kaze (32°13′ N, 78°5′ E), 3600 m (CWAN in SMFL). — **Jammu & Kashmir:** Zogi-La, 3500 m (CWAN in SMFL). Sonamarg, 2500 m (MHNG). Baltal, Sonamarg, 3000 m (CSNB, CWAN in SMFL). Kashmir, Gund, 2200 m (CWAN in SMFL). Ladakh, Lotsun, 3000 m (CWAN in SMFL). Ladakh, Taglang-La (CWAN in SMFL). Ladakh, Dras, 3500 m (MNHG). Yum, Himalaya-Geb., 4000 m (MNHG). Nubra valley, Sumur village, Samstaling monastery, 3200 m (observ. G. Padfield 15. vii. 2001, in email). — **Uttaranchal:** Gangotri Distr., near Gangotri, 30°59.355′ N, 78°56.414′ E, 3300 m (CSLL). Utar Kashi–Gangotri, 30°99.314′ N [*sic*], 78° 94.035′ E [*sic*], 3000–3600 m (CSLL). Badrinath Distr., 30°44.622′ N, 79°29.664′ E, 3100 m (CSLL). NW India, Kumaon-Himalaya, Kilbury, 2400 m (CAHS). — **Punjab,** Simla, Himalaya, 2300 m (SMFL, MNHG). — **Chitral,** Yersin, 4000 m (MNHG).

Most of the localities shown by Näss1g (1983: 99, fig. 4) are also included in the map. Generally, only localities which we were able to confirm on maps are included. — For further data see also the detailed locality list in Brechlin (2001: 96–97, specimens not examined by us).

Saturnia lindia is the western species of the subcomplex *lindia-rosalata-bonita,* with a wide range from NW India to Afghanistan.

Diagnosis: A large, robust species in the group. It is on average much more greyish and has much less reddish pattern on the hindwing, compared to *S. rosalata* and *S. bonita*. However, there is also much geographical variation, with the least colourful and most greyish specimens in the dry areas and the darker, more colourful specimens with a higher proportion of red pattern in the more humid areas. The hw. antemarginal line is usually consisting of white and black scales, not in ground colour like in many other species. Fw. in ♂♂ are usually more or less triangular, not falcate, with a round apex.

Description: ♂ (Figs. 24–25, 27, 30): Ground colour greyish, mixed with white and black scales; the proportion is variable, and specimens may look brighter of darker grey. Antennae wide, ochreous, quadripectinate, with ca. 28–32 segments, longest rami ca. 2.7–2.85 mm, total length ca. 13–15.5 mm. Legs with greyish hairs on the tibia, rarely with a slight pink tint; abdominal scales and hairs dorsally greyish (i.e., a mixture of white and black scales, often beginning with black scales/hairs on the first ca. ¾ of the segment and ending whitish, showing a ringed appearance), in specimens from humid localities more brownish and less ringed; ventral side more or less unicolourous beige to cream-coloured. Lfw. 45–51 mm in specimens collected in the wild (reared specimens usually much smaller). Fw. triangular (not falcate), with round apex. Fw. ocellus ca. 7–8 mm maximal diameter. Undulate lines rather wavy than zigzagged. Submarginal dark brownish, to a variable degree with white dots along veins. Hw. with a variable degree of pinkish to reddish colour in median field, beginning at the costal side; in some specimens also extending into basal field, see illustrations; hw. postdiscal lines rather wavy than zigzagged; hw. antemarginal line is usually greyish, i.e. a mixture of white and black scales. Hw. ocellus ca. 7–9 mm maximal diameter. Uns. similar, but less pattern, more unicolourous, on average brighter than ups.

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There is much variability; specimens like the one from Zogi-La (Fig. 24) much resemble *S. bonita* or *S. rosalata* (this specimen has not yet been barcoded), specimens from Shimla (Fig. 25) are very contrasting, while most western specimens (Afghanistan, Pakistan, Kashmir, Spiti etc.) are looking more faded and greyish.

♂ **genitalia** (Fig. GP1: 3–4; see also Nässig 1983: fig. 3c–f, Brechlin 2001: figs. 22–24): There appears to be a large variability in ♂ genitalia of *Saturnia lindia* when comparing the many pictures, which does, however, obviously not correspond with barcode differences; perhaps more DNA analyses may be necessary. – Genitalia on average larger than in the closely related species *S. bonita* and *S. rosalata*. Uncus short and narrow, furcation begins closer to the tip than in other species. Saccus very broad. Dorsal (apical) part of valves round to slightly acute; ventral process (harpe) broad, apically round, strongly bent outward. Processi of the juxta relatively smaller than in *S. bonita* and *S. rosalata*. Phallus with large sclerotized thorn and sclerite.

♀ (Figs. 26, 28–29, 31–32): Similar to the ♂♂, of same colour (and variability range), with usual sexually dimorphic characters, such as different antennae and more rounded, compact wings. Antennae bipectinate (but apical pair of rami not fully reduced, so that there are short "horns" indicating the other two [apical] rami), with ca. 25–27 segments, longest rami 0.9 mm, length in total ca. 11–12 mm. Tibiae with greyish hairs, rarely with a slight reddish tint. Lfw. ca. 46–51 mm, with round apex. Fw. ocellus 7 mm maximal diameter, hw. ocellus ca. 7–10 mm.

Ecological observations: *S. lindia* is a mountain species, known from ca. 1500–4000 m (according to the labels). It occurs over a wide range of gradually different annual rainfall (regarding time and intensity) from dry western and inner-Himalayan to humid and rainy places in the East and South. According to label data the imagines are on the wing in vi.–viii. (specimens fly usually later at higher localities); reared specimens in Germany (at 130 m elevation) hatched in spring to early summer after outdoor hibernation in [iv.–]v.–vi.

Preimaginal instars: The first observation of the larva of *Saturnia lindia* was probably that by Günter Ebert during his 1961 expedition to Afghanistan, near Kotkai. This was published in a very short way and illustrated only nearly 50 years later, in 2010 (Ebert 2010: 244 [legend], figs. 161/162). The preimaginal morphology of this species was described in detail (and figured in colour) by Nässig (1983, reared 1980 on *Corylus avellana* and in subsequent years also on *Betula* and some other plants, Nässig 1983: 90); also Miranda & Peigler (2007: 435, on *Populus deltoides*) and Lampe (2010: 296, 360, on *Betula pendula*) reared the species from the same stock (all these collected by the late Dr. Werner Thomas in 1980 near Sonamarg in Kashmir) and published caterpillar photos from that origin. We reproduce a few pictures from these years here (Figs. PIP I: o–q). Weisz (1996, unpubl.) gave some details about ecology and early instars of *S. lindia* in the Indian Spiti valley: eggshells and larvae (L_{3-5}) were found hidden in the lower parts of *Hippophae* sp. bushes in the river valley in early viii. The prominent anal scoli of fullgrown Spiti larvae are more orangy-yellow than in the Kashmir larvae described by Nässig (1983), where they were darker reddish. A few ♂♂ arrived at light between 20:40 and 22:30 h. A fullgrown 5th instar larva and hatched eggshells found in the river valley and a ♂ are figured. For a comparison of the preimaginals of the *lindia*-subcomplex see illustrations on PIP I and Tab. 2.

Discussion of the *grotei*-complex

From external morphology, ♂ genitalia and behaviour, the *grotei*-complex clearly falls into two subcomplexes: *Saturnia grotei* and *S. paragrotei* versus *S. lindia, S. rosalata* and *S. bonita*. The barcode analysis suggests a slightly different relationship, with *S. grotei* and *S. paragrotei* appearing to be early offsplits and the 3 others the terminal branches, being closely related to each other. The finding that there are obviously two different species hidden under *S. grotei sensu auctorum*, well-separated by 2–3 % difference in the mtDNA barcode, was quite a surprise. The differences between *S. lindia, S. rosalata* and *S. bonita* (the *lindia*-subcomplex) are much smaller (only 1–2 % in the barcode analysis), but nevertheless appear to be clear enough, and in combination with further differences in morphology of imagines and larvae are sufficient to interpret the 3 taxa as separate species. Within the *lindia*-subcomplex, there is a strong tendency to change the colouration from greyish-brown, often nearly without red, in the dry western and northern areas to much more vivid colouration, with clear red pattern elements, in the more humid eastern and southern Himalaya, obviously in correlation with annual rainfall ("more water, more colour": the annual precipitation along the Himalaya range is much higher in the East than in the West, and at any part gradually decreases from the first mountains in the South facing the Monsoon to the secondary chains behind these in the North). This is not only true for *S. lindia* itself (Nässig 1983), but includes also the more colourful *S. rosalata* and *S. bonita*.

Larvae (known for *S. lindia, S. rosalata* and *S. bonita* only, see PIP I: o–q and Nässig 1983) are green in L_1 (with a green head in *S. lindia* and a black head in *S. bonita* and *S. rosalata*) and tend to be more or less green with only some blackish pattern; older larvae have pronounced pattern elements at the anal end. *S. rosalata* is generally more similar in preimaginals to *S. lindia* than to *S. bonita*. The known cocoons (of *S. lindia* and *S. bonita*) are single-walled, with a relatively large preformed exter-

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Plate 3: *Saturnia* specimens. Orange lines separating species. **Figs. 33–40: *Saturnia bieti*. Fig. 33:** ♂, China, Sichuan, Qingmai, 3000 m, leg. M. Janata, CSNB. **Fig. 34:** ♂, Sichuan, Jinliang, leg. E. Kucera, CSNB. **Fig. 35:** ♂, Yunnan, Bailakou-Pass, 3750 m, leg. S. Murzin & I. Shokhin, CSNB. **Fig. 36:** ♀, Yunnan, Zhongdian, leg. B. Šiška & T. Spevár, CSNB. **Fig. 37:** ♂, Yunnan, Zhongdian, 3200 m, leg. B. Šiška, CSNB. **Fig. 38a:** ♂, Tibet, Jiulong, Shangri La, 3200 m, leg. G. Bretschneider, CSLL. **Fig. 39:** ♂, Myanmar, Kachin, rd. to Mt. Inwa Bum, 3008 m, leg. S.N., S. Löffler & N. Langer, CSNB. **Fig. 40:** ♀, Myanmar, Kachin, rd. to Mt. Inwa Bum, 3008 m, leg. S.N., S. Löffler & N. Langer, CSNB. — **Figs. 41–47: *S. tsinlingshanis*. Fig. 41:** ♂, Shaanxi, Taibaishan in Tslinlingshan, 1500 m, CSNB. **Fig. 42:** PLT ♂, Shaanxi, Taibaishan in Tslinlingshan, ["F" = code for 3000 m elevation,] leg. H. Höne, ZFMK. **Fig. 43:** ♂, Sichuan, Emei Shan, 1600 m, CSBN. **Fig. 44:** ♂, Sichuan, Gongga Shan, CSNB. **Fig. 45:** ♂, Sichuan, Qingshen Shan, 1400–1800 m, CSNB. **Fig. 46:** ♂, Yunnan, Mt. Dabaoshan, CSNB. **Fig. 47a:** ♀, Gansu, Kialing river (= Jialing Jiang?), Lihsien, coll. O. Bang-Haas, ETHZ. — **Figs. 48–50: *S. tibetanna*. Fig. 48:** HT ♂, Tibet, Yigong, 2300–2400 m, leg. Wang, ex CSNB in ZMHU. **Fig. 49:** PT ♂, Tibet, Ningtri pr., Pome, 2600 m, leg. P. Westphal, CSNB. **Fig.**

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50: PT ♀, Tibet, Tomi (Tangmai), 2200 m, leg. V. Paulus, CSNB. — **Figs. 51–53:** *S. anna*. **Fig. 51:** ♂, Nepal, Gupa Pokhari, Milko Danda ridge, 2900 m, leg. M. G. Allen, CSNB. **Fig. 52:** ♀, Nepal, Dolakha, Jiri, 2200 m, leg. H. Schnitzler, CSNB. **Fig. 53:** ♂, [India,] Sikkim, Arivaal, Dalapchaud, 1500 m, leg. T. Haruta, CSNB. — **a** = ups., **b** = uns. — Photos S.N., except Figs.: 38a (S. Löffler); 47a (U. Brosch). — Pictures not to the same scale. Scale bar (where present) = 1 cm. Labels not always to the same scale (large labels often slightly reduced).

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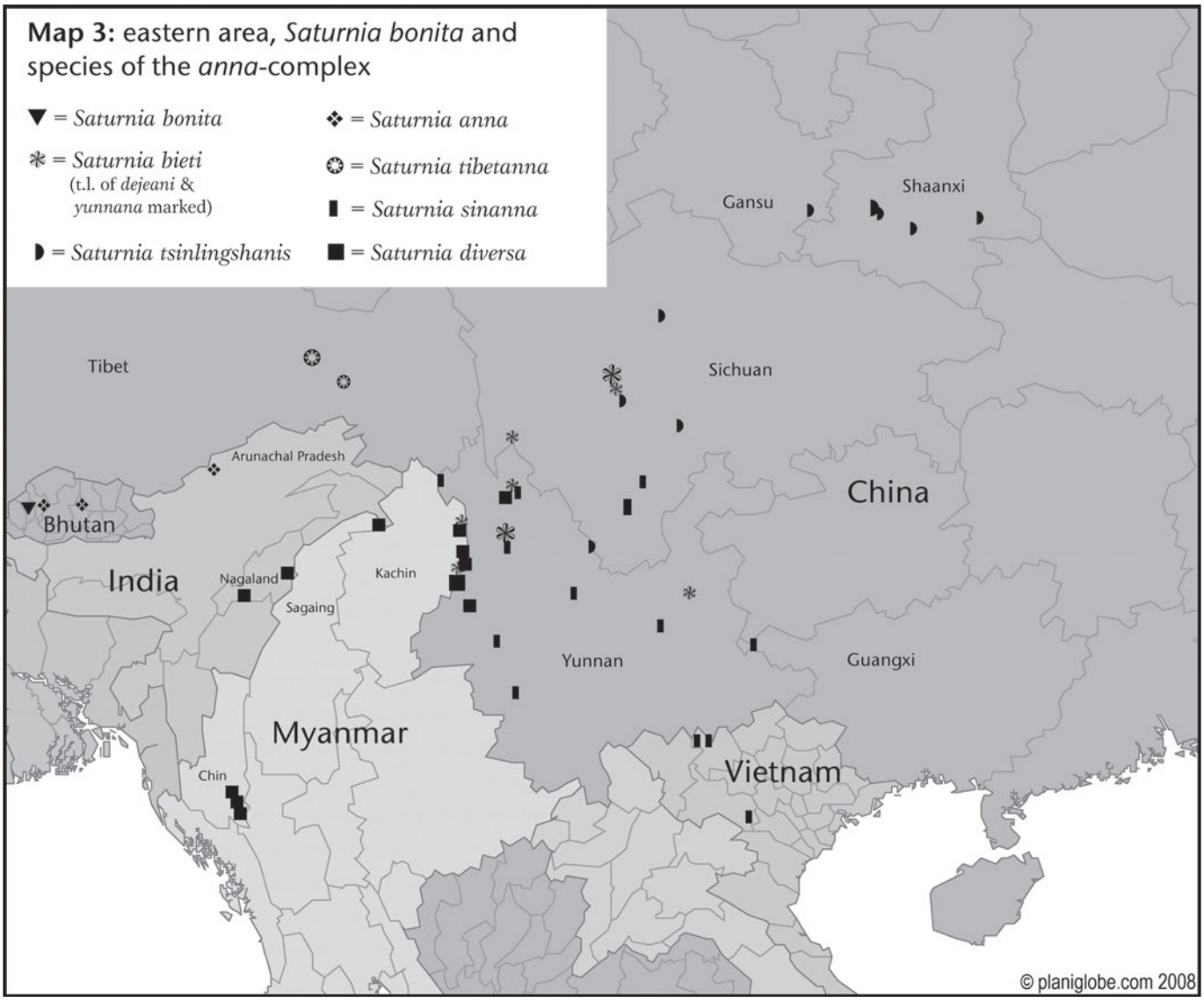

Map 3: Eastern area, *Saturnia bonita* and species of the *anna*-complex.

nal (i.e., not smoothly included into wall, but just looking "attached") exit of valve-like "Reuse" type; the wall of the cocoon is not perforated and net-like as in many related species of *Saturnia,* but densely closed.

The variability range of external morphology found in *S. lindia* (including variability in ♂ genitalia!) is quite high. Further studies should be directed to the question whether there might be other "cryptic" species hidden in the taxon. We have not yet barcoded all populations; from several localities, there is no fresh material available.

B) The species-complex of *Saturnia anna*

Saturnia anna was originally described from the eastern Himalaya (Darjeeling). Already DE JOANNIS (1928–1930) mentioned "*Caligula anna*" from Vietnam without describing it in more detail or illustrating it (compare NÄSSIG 1994b).

There is a superficial similarity of the different populations from the central Himalaya to western and southwestern China and northern Vietnam which lead most earlier authors to the preliminary treatment of them just as populations (subspecies or unnamed synonyms) of one species, *S. anna*. Only *S. bieti* was described with full species rank, due to the differences compared with *S. grotei*[!] figured in a drawing of ♂ and ♀ from Darjeeling by BUTLER (1881: pl. XCIV, figs. 3 & 4; compare OBERTHÜR 1886), and a figure of the ♂ of *S. grotei* in MOORE (1859) which is a little different from that in BUTLER.

When examining larger series of this complex in the late 1990s and early 2000s, rather clear and obviously stabile differences in size, wing pattern, colouring and shape as well as in the ♂ genitalia structures of some of the different populations became visible after which the taxa could be differentiated. As nothing was known then about the early instars and ecology of most of the taxa (below we provide much new information on the preimaginals of the group), and due to the overall similarity of the specimens we hesitated to decide about a specific or subspecific or synonymic status for the populations for a long period. Recently, the results of the barcode studies provided hints how to interprete the situation.

ZHANG et al. (1986) delivered some probably reliable locality data for *"Caligula anna"* in Tibet, and they figure

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on their colour plate 8, fig. 64, under this name a ♀ of *Saturnia bieti,* again with locality data. Fortunately, we also received fresh material of *S. diversa* from Tibet and Yunnan from places in the same area, so that we know that *diversa* and *bieti* live sympatric in SE-Tibet. Xue & Wang (1989) figured "*Caligula lindia bonita*" (a ♂ figured on their pl. IX, fig. 4, which in fact is *S. bieti*) and "*Caligula anna*" (a ♀ figured on their pl. X, fig. 1, which is *S. diversa*) from the same places in S-Tibet. Also, in material from Kachin State in Myanmar collected by S. Löffler, M. Langer & S.N. in v. 2006 there were both *S. bieti* and *S. diversa,* so that we know that these two species are also living sympatric in the highlands of NE-Myanmar. At least *S. bieti* and *S. diversa* therefore must necessarily be two different species. Further overlap can be expected between *S. tsinlingshanis* and *S. bieti* as well as *S. sinanna* sp. n. or between *S. diversa* and *S. sinanna* sp. n. (for details, see distribution paragraphs and maps).

Based mainly on the results of barcode studies and imaginal morphology (there is not very much known about larvae so far), we decided to subdivide this species-complex into the following 6 different species:

Saturnia bieti Oberthür, 1886

Saturnia bieti Oberthür (1886: 31; pl. 7, fig. 58). – LT ♀ (designated above); in BMNH [examined]. – L.t.: [China], "Thibet"; most probably somewhere in E-Tibet [= Xizang Zizhiqu] or NW-Yunnan or SW-Sichuan.

Here illustrated: Figs. 5–6, 8, 33–40; GP2: 7–10; Map 3.

= *Caligula anna dejeani* Bouvier & Riel, 1931, **syn. n.** – NT ♂ (designated above); in SMFL [examined]. – L.t. "Ta-tsien-Loû". (This name *dejeani* was not used in literature since its description. The NT ♂ specimen [see Fig. 6], collected syntopically to the original, but lost, STs, is a small, dark specimen of *S. bieti*.) This NT specimen came from Oberthür's collection, and either he himself or someone else in the chain leading to the collection of C. Commerell (who eventually donated his collection to SMFL) already correctly identified the specimen as a synonym of *S. bieti* (the label as a "Cotype" of *S. bieti,* of course, is not correct because this specimen was collected in 1903, ca. 15 years after the original description of *S. bieti*).

= *Caligula anna yunnana* Mell, 1939, **syn. n.** LT ♂ (designated above); in ZFMK [examined]. – L.t.: China, NW Yunnan, Likiang [= Lijiang Naxizu Zizhixian]. (Mell described *S. bieti* a third time; evidently he did not know Oberthür's taxon, because the name is not showing up in Mell's description.)

Cited in literature as:

Saturnia bieti: Oberthür (1886: 31, pl. VII, fig. 58 ♀); Kirby (1892: 773); Naumann et al. (2008: 151; original combination retained).

Saturnia (Rinaca) bieti: Nässig (1994a: 257, status unclear).

Caligula bieti: Jordan (1911: 218, pl. 32a ♂); Bouvier (1936: 212, 214); D'Abrera (1998: 36, 37, fig. ♂, ♀; no paratype, as declared in error by D'Abrera, see in catalogue above).

Caligula anna: Bouvier & Riel (1931a: 46); Zhang et al. (1986: 25, pl. 8 ♀).

Caligula anna yunnana: Mell (1939: 148).

Caligula lindia bonita: Xue & Wang (1989: 44, pl. IX, fig. 4 ♂ [misidentification]).

Distribution (Map 3):

China: Tibet [recte **Yunnan**?], Jiulong County, Shangri La, 3200 m (CSLL). "Frontière orientale du Thibet. Chasseurs indigènes du P. Déjean, 1905", ex coll. Oberthür via coll. C. Commerell in SMFL. – **Yunnan,** Li-Kiang [= Lijiang, 26°57′ N, 100°15′ E, 2475 m] (ZFMK; 1 ♂ GP 740/95 WAN). Zhongdian, 3200 m (CSNB, CWAN in SMFL). Bailakou Pass env., 3750 m (CSNB). Mt. Dabao Shan, Huaping County (CSLL). N-Yunnan, A-tun-tse, ca. 3000 m, leg. Höne (ZFMK). – **Sichuan,** road Menghugang–Kangding, 29°49.955′ N, 102° 2.827′ E, 3000 m (CSNB). Qingmai, 28°48′46.7″ N, 99°52′9.2″ E, 3000 m (CSNB). Jinliang, Tcho-nin (CSNB). Tá Tsien Loû [= Kangding, 30°3′ N, 102°2′ E], Tche To (ZFMK; NT *dejeani,* SMFL).

Note: There are further records for the modern [SE] **Tibet** which may be records of *Saturnia bieti* (but it could also be *S. bonita, S. tibetanna* or other species), e.g., in Zhang (1986) [as *Caligula anna*]: Zedang (Shannan District, 29°14′24.55″ N, 91°46′6.37″ E), Changdu (?), Linzhi (29°38′44.84″ N, 94°22′22.85″ E), Jiacha (29°8′38.58″ N, 92°35′53.87″ E), Langxian (29°2′40.76″ N, 93° 4′19.83″ E), all at around 3070–3600 m. Further Xue & Wang (1989) [as *Caligula lindia bonita;* but *S. bieti* is illustrated by them]: Jiacha, 3260 m; their record of Yatong, 3000 m is the L.t. of the true *S. bonita*. We have not plotted these on our maps because we have not seen the specimens, and there are repeatedly misidentifications in Chinese literature (see also below under *S. sinanna* sp. n.).

Myanmar: Kachin State, rd. Kanphant–Mt. Inwa Bum near pass, 26°10′31.0″ N, 98°30′3.4″ E, 3008 m (CSNB, CSLL). Chudu Razi Hills, ca. 40 km E Kawnlangphu (CSNB).

Saturnia bieti is probably also found within today's Tibetan borders; other Chinese localities are in Yunnan and Sichuan, with a few further reports from Myanmar, Kachin State.

Diagnosis: *S. bieti* generally is the smallest species in the species-complex of *S. anna*, and is characterized by its typical greyish white ground colour (in specimens from Myanmar a little more yellowish) in combination with black and rosy-white wing ocelli and completely missing pink portions of the hw.

Description: ♂ (Figs. 6, 8, 33–35, 37–39): Ground colour greyish white, suffused with black and more or less yellow scales. Fresh specimens from NE Myanmar are more vividly coloured, with a overall yellowish touch. Antennae quadripectinate, with ca. 27 segments, longest rami 2.2 mm, length in total 11–12 mm. Legs with long pink hairs on the tibia. Lfw. 35–45 mm, with relatively falcate apex, with pinkish violet apical field and with dark violet subapical dot. Fw. ocellus quite intensively coloured with broad outer black ring, followed by an inner rosy-white ring and inner black portion with transparent halfmoon, with 7.0–9.5 mm maximal diameter. In the basal part of the median area a light field without black marking. Hw. without any pink colouration, hw. ocellus similar to that of the fw., with 8.0–9.0 mm maximal diameter. Postmedian zigzag lines of both fore-and hw. very wavy, curved less far than in the nearest relative *S. tsinlingshanis* to basal and marginal area. Submarginal line consisting of a row of white triangles, marginally followed by small dots of the same colour. Colour and pattern on ventral side almost similar.

♂ **genitalia** (Figs. GP2: 7–10): The uncus with only slightly furcate processi, close and narrow base. Saccus small and round. Valve apex round, dorsal border rather straight, only slightly bent upwards. Ventral valve processi (harpe) narrow and clearly bent downward. Phallus thorn longer, less bent and narrower than in *S. anna,* vesica processi dorsally in the centre and ventrally on the left side.

♀ (Figs. 5, 36, 40): Very similar to the ♂♂, of same colour, with typical sexually dimorphic characters, such as different antennae

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and more rounded, compact wings. Antennae bipectinate, with ca. 26 segments, longest rami 0.6 mm, length in total 10 mm. Lfw. 38–48 mm, with round apex. Fw. ocellus relatively small for the group, 9–10 mm maximal diameter, hw. ocellus 7–9 mm maximal diameter.

Ecological observations: From data of the rarely collected specimens we found a flight activity from mid-April to early July, with a peak in v.–vi. Judging from the very high localities where the species is found (ca. 3000–3750 m) we believe in an only very short imaginal activity period, depending on the weather conditions of its extreme habitat. Specimens collected by M. Langer, S. Löffler and S.N. in Myanmar, Kachin State, close to the Chinese border, simultanously with *S. diversa,* showed a flight activity of the ♂♂ from around 19:20 to 20:00 h and of the ♀♀ of around 20:00 h, while *S. diversa* was collected much later, only around and after midnight. Deposited ova of a ♀ of *S. bieti* were slightly larger than those of *S. anna* or *S. diversa,* ca. 2.1 mm × 1.5 mm × 1.2 mm in size, and lighter brown; unfortunately, probably due to long transport back to Germany and very bad weather conditions on the way, no larvae hatched.

Preimaginal instars: Thus far unknown (except eggs, see above).

Saturnia tsinlingshanis (Mell, 1939), comb. n.

Caligula anna tsinlingshanis Mell (1939: 148). — LT ♂ (designated above); ZFMK [examined]. — L.t.: China, "Taipeishan im Tsinlingshan" [= Shaanxi, Qingling Mountains, Taibai Shan], 1700–3000 m, 19. vi.–2. vii. 1935.

Here illustrated: Figs. 9, 41–47; GP2: 11–14; PIP I: z; PIP II: a; Map 3.

Cited in literature as:

Caligula anna tsinlingshanis: Mell (1939: 148).

Caligula tsinlingshanis: D'Abrera (1998: 38, 39, fig. ♂).

Distribution (Map 3): **China: Shaanxi,** Taibai Shan, Tsinlingshan, [3000 m] (ZFMK, 1 ♂ GP 299/86 WAN; ZMHU, BMNH). Southern Taibei Shan, Tsinling Mts., Houzhenzhi village, 33°53′ N, 107°49′[59′?] E, 1500 m (CSNB, CWAN in SMFL). Taibei Shan, Qinling Mts., 33°56′ N, 107°44′ E, 2600 m (CSLL). Ning Shan, near Ningshan Town, 33°44′ N, 108°26′ E, 1500 m (CSNB, CSLL). San Tai Shan, 100 km SE Xi An, 33°42′ N, 109°37′ E, 1600 m (CSNB). — **Sichuan,** Emei Mt., 1600 m (CSNB, CWAN in SMFL, CSLL). Qingcheng Shan, 31°12′ N, 102°47′ E, 1500–1800 m (CSNB). Qingcheng Shan, 60 km W Chengdu, 1500 m (CSLL). Jinliang, Tchonin (CSNB). Gongga Shan, near Moxi village, 29°40′ N, 102°6′ E (CSNB, CWAN in SMFL). — **Gansu,** Lihsien, Kialing river, 2500 m (ETHZ). — **Yunnan,** Dabao Shan, Huaping County (CSLL, CSNB).

Saturnia tsinlingshanis is a Chinese species, not only found in Shaanxi in the Tsinlingshan Range, from where it was described, but also in Gansu and even just easterly of the distribution area of the closely related *S. bieti* in Sichuan and Yunnan, with a possible overlap with *S. bieti* in the area of Garze/Kardze/Dartsemdo, the former Tatsienlou, as well as with the less closely related *S. sinanna* in S Sichuan and N Yunnan.

Diagnosis: *S. tsinlingshanis* is the largest species in the species-complex of *S. anna*. It is characterized by its yellowish-grey ground colour, large wing ocelli and a little reddish brown colouration in parts of the hw. The first postdiscal zigzag line of the hinwing is very prominent. The fw. form of ♂ specimens is quite variable, changing from almost round to expressively falcate.

Description: ♂ (Figs. 41–46): Ground colour yellowish-grey, mixed with black and more or less reddish brown scales. Fresh specimens are more vivid, with a yellowish touch in total. Antennae quadripectinate, with ca. 28 segments, longest rami 2.1–2.5 mm, length in total from 9.5 mm [one very small specimen, most specimens:] 12–14 mm. Legs with long pink hairs on the tibia. Lfw. 43–57 mm, with variable form of apex (most specimens a bit falcate, some quite acutely falcate, a few more rounded; variation found in series from one locality!), with violet apical field with dark violet subapical dot. Fw. ocellus with typical broad outer black ring, followed by an inner brownish pink ring and inner lentoid black portion with transparent halfmoon, large, with 8–11 mm maximal diameter. In the basal part of the median area a light field without black. Hw. with some reddish brown colouration in the median area towards upper margin, hw. ocellus similar to that of the fw., inner black portion more rounded, with 8–9.5 mm maximal diameter. Postmedian zigzag lines of both fw. and hw. very wavy, curved far to basal and marginal area. The first postdiscal line of the hw. usually very prominent and of distinctively pinkish brown colour. Submarginal line consisting of a row of yellowish-white triangles, marginally followed by small dots of the same colour. Colour and pattern on ventral side similar.

♂ genitalia (Figs. GP2: 11–14): GP larger than that of *S. bieti*. Uncus similar to *S. bieti*, but slightly longer and slightly more separately furcate, apically often a bit converging. Saccus broader and longer than in *S. bieti*. Valve apex round and dorsal border convex, nearly without bristles. Ventral valve processi (harpe) with very large sclerotized tip, bent laterally and ventrally. Sacculus well-developed. Phallus with a very long thorn, a bit dentate; vesica processi dorsally to the right and ventrally to the left.

♀ (Fig. 47a, PIP I: z): Very similar to the ♂♂, of same colour, with typical sexual-dimorphic characters, such as different antennae and more rounded, compact wings. Fw. with rounded apex. (No ♀ available for measurements.)

Ecological observations: *S. tsinlingshanis* occurs at altitudes of ca. 1500–3000 m (as far as the data is provided on labels), most specimens 1500–1800 m, and was collected so far in v.–early viii., with a peak in vi.

Preimaginal instars: The species was reared from Shaanxi populations by V. Siniaev but unfortunately there exists only a very incomplete series of low quality photos without instar documentation and other information. Larvae were reared in Moscow on *Tilia* sp. We figure a probably fullgrown larva (ca. $L_{[4/]5}$, Fig. PIP II: a) which shows distinctive red tubercles with black rings,

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Plate 4: *Saturnia* specimens. Orange lines separating species. **Figs. 54–55:** ***Saturnia anna*. Fig. 54:** ♂, India, W Bengal, Darjeeling, leg. W. Thomas, ex CWAN in CSNB. **Fig. 55:** ♂, Bhutan, Trongsa, 3040 m, leg. P. Kautt & S.N., CSNB. — **Figs. 56–65:** ***S. sinanna*. Fig. 56:** HT ♂, Sichuan, Abulandan Shan, Dechang, ex CSNB in SMFL. **Fig. 57:** PT ♀, same data as HT, CSNB. **Fig. 58a:** PT ♂, Massif du Kang Shau[?], Lac Emehlei, Dali, [leg.] Bousquet, MNHN. **Fig. 59:** PT ♂, Yunnan, Yunlong, Daxueshan, ca. 4000 m, leg. Li, CSNB. **Fig. 60:** PT ♀, Yunnan, Baimaxue Mt., Dexin env., ca. 4500 m, leg. Wang & Li, CSNB. **Fig. 61:** PT ♀, Yunnan, Maguan, Suiyuanqing, 2500 m, leg. Li & Tu, CSNB. **Fig. 62:** PT ♂, Vietnam, Mt. Fansipan, Chapa env., 1600–1800 m, CSNB. **Fig. 63:** PT ♂, Guangxi, Xiling, Datouzhang Mt., 1600 m, leg. Li et al., CSNB. **Fig. 64:** PT ♀, Guanxi, same data as Fig. 63, CSNB. **Fig. 65:** PT ♀, Vietnam, Mt. Fansipan (W), Chapa, 1600–1900 m, leg. Mong, CSNB. — **Figs. 66–74:** ***S. diversa*. Fig. 66:** ♂, Myanmar, Kachin, Mt. Inwa Bum, 3008 m, leg. S.N., S. Löffler & M. Langer, CSNB. **Fig. 67:** ♂, Kachin, Kanphant village, 1642 m, leg. S.N., S. Löffler & M. Langer, CSNB. **Fig. 68:** ♀, Kachin, Chudu Razi Hills, E Kawnglangphu, via A.M. Cotton, CSNB. **Fig. 69:** ♂, India, Nagaland, 25°40′ N, 90°2′ E, 1900 m, leg. E. Grigorev & V. Siniaev, CSNB. **Fig. 70:**

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♂, Myanmar, Chin, Natma Taung N.P., 2350 m, leg. Langer, Löffler & S.N., CSNB. **Fig. 71:** ♀, Chin, data as Fig. 70, CSNB. **Fig. 72:** ♂, Xizang Zizhiqu (E Tibet), Meilixueshan, Yanging, 6000 m[?], leg. Wang & Li, CSNB. **Fig. 73:** ♂, Yunnan, Yunlong county, Fengshuining Mts., 2460 m, CSNB. **Fig. 74:** ♀, Xizang Zizhiqu, data as in Fig. 72, CSNB. — **a** = ups., **b** = uns. — Photos S.N. — Pictures not to the same scale. Scale bar (where present) = 1 cm. Labels not always to the same scale (large labels often slightly reduced).

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the sublateral scoli on the abdomen placed within irregular black patches, and large reddish brown dots with a prominent black ring laterally on the last legs; the anal plate is not visible. Young instars (probably L_2? Picture is out of focus, thus not included on plate) are yellowish green with orangy scoli, except the dorsal scoli pair on abdominal segment 8, which stands in a united black dot, and, for some specimens (individual variation?) also 2 dorsal black dots on the prothorax. A medium-sized caterpillar (ca. $L_{3/4}$? Picture is out of focus, not on plate) is yellowish green with orangy scoli, black hair bases for the most prominent bristles on the scoli, and reddish brown dots with a black ring laterally on the last legs, and a similar reddish brown dot on the anal plate. For a comparison with other species of the *anna*-complex, see Tab. 3.

Saturnia anna Atkinson (*in* Moore), 1865

Saturnia anna Atkinson *in* Moore (1865b: 818). — LT ♂ (designated above, Fig. 3); in ZMHU [examined]. — L.t.: "Darjiling" [= N-India, West Bengal, Darjeeling].

Here illustrated: Figs. 3–4, 51–55; GP2: 15–16; Maps 1–3.

Cited in literature as:

Saturnia anna: Atkinson *in* Moore (1865b: 818); Kirby (1892: 773); Hampson ([1893]: 22).

Saturnia (Rinaca) anna: Nässig (1994a: 257).

Caligula anna: Jordan (1911: 218); Seitz (1928: 516, pl. 55A a ♂); Bouvier & Riel (1931a: 46; 1931b: 46); Bouvier (1936: 212, 214, pl. V, fig. 7 ♂; this specimen illustrated in b&w is probably not a real *S. anna,* but no data is provided); Wang (1988: 461); Haruta (1992: 93, pl. 25, fig. 8 ♂; 1994: 159); Allen (1993: 64, col. pl. 47.c ♂); D'Abrera (1998: 36, 37, fig. ♀).

Additional note: Sathe (2007: 23) published a note on a species from the Western Ghats in W-India, which he named *"Saturnia anna"*. It is not illustrated, and from the description in the text we were unable to identify the correct genus. We have not seen any member of the *grotei*-group from (south-)western India so far; the Western Ghats appear to be too low for such mountain species. However, the bombycoid fauna of South India and especially the Western Ghats is very poorly studied, and surprises may be expected. Nevertheless, for the time being we believe in a misidentification.

Distribution (Maps 1, 2 & 3):

Nepal: Central Hills, 1800–2500 m (CWAN in SMFL). [Janakpur Prov.], Dolakha, Jiri, 2200 m (CSNB). [Bagmati Prov.], Chautara District, Gupa Pokhari, 2900 m (CSNB). Dhaulagiri Himal, 8 km

Tab. 3: Comparison of the known preimaginal instars of *Saturnia tsinlingshanis, S. sinanna* and *S. diversa* (see colour plate PIP II). — * = poor quality photos (out of focus) only available, most of them not included in plate.

Character	*Satunia tsinlingshanis* (PIP II: a)	*Saturnia sinanna* (PIP II: b–i, t–x)	*Saturnia diversa* (PIP II: j–s)
L_1 larva	Unknown [not photographed].	Larva totally black.	Larva totally black.
$L_{2/3}$ larva	[*Ca. $L_{2/3}$?:] Yellowish green with orangy scoli, except the dorsal scoli pair on abdominal segment 8, which stands in a united black dot, and, for some specimens (individual variation?) also 2 dorsal black dots on the prothorax.	Larva green, with black head, prothoracal and anal shields, little black dots above basolateral stripe; larvae from Kunming additionally little black pattern; scoli orangy coloured (Kunming: lateral scoli more yellowish). A whitish basolateral stripe and an indicated oblique yellowish-white stripe on most segments from the subdorsal scolus back downwards to the spiracles. — In L_3 most dorsal scoli (in Yunxian larvae), respectively (in Kunming larvae) only on meso- and metathorax and on a1 and a8, a9 turning more or less blackish.	L_2: Unknown [not photographed]. L_3: Ground colour green, head green, dorsal scoli whitish with black tip or with red ring and black tip, subdorsal scoli yellowish, basal scoli (within white bulgy longitudinal stripe) orangy red, little black dots above basolateral stripe, oblique yellowish lateral stripes per segment.
L_4 larva	[*Ca. $L_{3/4}$?:] yellowish green with orangy scoli, black hair bases for the most prominent bristles on the scoli, and reddish brown dots with a black ring laterally on the last legs, and a similar reddish brown dot on the anal plate.	(Yunxian larvae only:) Ground colour green, head whitish, dorsal scoli, prothoracal and anal legs black, anal shield dark red centre with black ring. Subdorsal and basal scoli yellowisch to orangy, whitish basolateral longitudinal stripe; oblique segmetal stripes present.	Ground colour green, head green, dorsal scoli whitish with black tip, subdorsal scoli dark yellowish, basal scoli (within white bulgy longitudinal stripe) red, little black dots above stripe; spiracles brown, oblique yellowish lateral stripes per segment.
Mature larva (L_5)	[*Ca. L_5?:] Ground colour green, distinctive red tubercles with black rings, the sublateral scoli on the abdomen placed within irregular black patches, and large reddish brown dots with a prominent black ring laterally on the last legs; the anal plate is not visible.	Ground colour and head green, short secondary yellow hairs all over; dorsal scoli black on whitish base, prothoracic shield black, anal shield and anal legs dark reddish centre with black and outermost yellow ring, basolateral scoli of a9 strongly enlarged, black, giving a somehow "rectangular" shape for the rear end of the body. Other scoli yellowish to orangy, little black dots above basolateral stripe; spiracles brown. Whitish basolateral and segmental oblique stripes.	Ground colour, head and prothorax green, short secondary yellow hairs all over; dorsal scoli bright sky blue with black bristle bases or larger dots, other scoli inconspicuous; anal shield black, anal legs blackish red; little black dots above basolateral stripe; spiracles brown. Whitish basolateral and segmental oblique stripes.
Cocoon	Unknown.	Brown, single-walled, net-like perforated; free preformed exit of "Reuse" type (like a valve). Cocoon more or less pear-shaped, with exit often obliquely at the head end.	Like in *S. sinanna*.
Pupa	Unknown.	Obviously quite similar to the pupa of *S. lindia* (see Tab. 2).	Like in *S. sinanna*.
Foodplant etc.	Unknown.	Unknown. Reared on *Liquidambar styraciflua* (Yunxian) and *Alnus* sp. (Kunming).	Unknown. Reared on *Salix*.

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SW Tatopani, 1200 m (CSLL). Mt. Kalinchok, 2 km N Tarebhir, 2600 m (CSLL). Sagamartha, 10 km SE Lukla, 3500 m, 6.–9. VI. 1999, leg. M. PETERSEN (CWAN in SMFL); Dagchu (HARUTA 1994).

India: West Bengal, Darjeeling, Tigerhill, 2400 m (CWAN in SMFL, CSNB). Darjeeling, Borlitta (BMNH). Sikkim (BMNH). Sikkim, Arivaal, Dalapchaud, 1500 m (CSNB). — Arunachal Pradesh, District Along, near Rapum, 28°53.176′ N, 94°24.941′ E, 2000 m (CSLL).

Bhutan: Thimpu Dzongkhag, 1.5 km NE Dochu La, 27°29′48″ N, 89°45′48″ E, 2820 m (CSNB, CSLL). Trongsa Dzongkhag, road Trongsa–Yotong La, 27°31′19″ N, 90°32′57″ E, 3040 m (CSNB).

The localities in Myanmar, China and Vietnam listed by BRECHLIN (2009a) for *Saturnia (Rinaca) "anna"* do not belong to *S. anna* proper, but to a conglomerate of other species, i.e., to the species-complex of *anna*. BRECHLIN (2009a: 50) also lists "N Thailand" for the species-complex of *anna;* however, we have some doubt about this (regrettably unspecified) locality record, and we never have seen any member of the *anna*-complex from Thailand although we have seen large amounts of material from there.

Saturnia anna is a South Himalayan species, only found in the rainy southern slopes, from Nepal across Sikkim and northern West Bengal to Bhutan and Arunachal Pradesh.

Diagnosis: *S. anna* is characterized by its generally greenish ground colour with a yellowish tint, few parts of pinkish red colouration of the hw., relatively small fw. and hw. ocelli, and falcate fw. of the ♂♂.

Description: ♂ (Figs. 3, 4, 51, 53–55): Ground colour dark green, mixed from yellow and blackish scales; older specimens are fading to a more yellowish colour. Antennae quadripectinate, with ca. 27 segments, longest rami 2.8 mm, length in total 15.5 mm. Legs with long greyish pink hairs on the tibia. Lfw. 51–56 mm (LT 55 mm), with relative falcate apex. Fw. ocellus relative small for the group, with 8–8.5 mm maximal diameter. Hw. in the median area towards upper margin mixed with a few pinkish red scales and hairs on the dorsal side, but generally quite reduced compared to the related taxa *S. sinanna* sp. n. and *S. diversa* mentioned below. Hw. ocellus with 6.5–8 mm maximal diameter. Postmedian zigzag lines of both fw. and hw. very wavy, curved relatively far to basal and marginal area. Submarginal line consisting of a row of yellowish-white triangles, marginally followed by small dots of the same colour. Colour and pattern on ventral side similar, with less prominent zigzag lines, a pink portion of the hw. is usually completely lacking.

♂ genitalia (Figs. GP2: 15–16): Rather large. Uncus widely furcate with well-separate tips; broad at base. Saccus broad and large. Valve apex slightly sclerotized, round, dorsal border line well bent. Ventral valve processi (harpe) rather small, but strongly sclerotized and ending in a lateral hook; with a concave indention below the harpe. Phallus with a short and broad, strongly bent thorn; dorsal vesica sclerite strongly dentate, vesica processi dorsally small and to the left and ventrally large and to the left.

♀ (Fig. 52): Very similar to the ♂♂, of same colour, with typical sexually dimorphic characters, such as different antennae and more rounded, compact wings. Antennae bipectinate, with ca. 29 segments, longest rami 0.6 mm, length in total 12 mm. Tibiae with more pinkish hair, but still grey. Lfw. from 49–51 mm, with round apex. Fw. ocellus relatively small for the group, 8.5–9 mm maximal diameter, hw. ocellus 7–9 mm diameter.

Ecological observations: Compared to the fact that *S. anna* is widely distributed along the rather well-studied southern slopes of the Himalaya, the information on its ecology is quite restricted. From the data of collected specimens we noted a flight activity from March to early August, with a peak of mid to end of June. Specimens were collected in altitudes from 1500 to 3040 m. Collecting sites in Bhutan consisted of evergreen cloudy forest.

Preimaginal instars: Thus far unknown. Sometimes larvae are shown on some private websites in the WWW under the name "*Caligula anna*". However, we think that these larvae are usually other species (especially *S. diversa* and *S. sinanna* sp. n.).

Saturnia tibetanna sp. n.

HT ♂ (Fig. 48): Volksrepublik China, Tibet, Yigong, ca. 30°30′ N, 94°80′ E [*sic*, = 95°20′ N?], 2300–2400 m, Kauf Sept./Okt. 1996, leg. WANG [collected v.–IX. 1996?], via Huang HAO, GP 337/99 NAUMANN, BC SNB 0370 (CSNB), assigned to ZMHU.

PTs (2 ♂♂, 1 ♀; Figs. 49–50), all **China, Tibet:** 1 ♂, Yigong env., ca. 2000 m, ca. 30°30′ N, 94°80′ [*sic*] E, Kauf IX./X. 1996, leg. WANG [collected v.–IX. 1996?], via Huang HAO (CSNB). 1 ♀, Tomi (Tangmai), 2200 m, 1.–5. VII. 1996, leg. V. PAULUS, BC SNB 1913 (CSNB). 1 ♂, E, Nginghri Prov., Pome, 2600 m, 8. VI. 1996, leg. R. WESTPHAL, GP 146/97, BC SNB 1914 (CSNB).

Type labels will be added accordingly.

Here illustrated: Figs. 48–50; GP2: 17–18; Map 3.

Derivatio nominis: Named as the Tibetan relative of the *anna*-complex.

Obviously not yet cited in literature.

Distribution (Map 3): *Saturnia tibetanna* is found only within today's Tibetan borders (in east central Tibet), not in the former "Eastern Tibet", now Yunnan or Sichuan.

Diagnosis: Specimens of *S. tibetanna* are lighter, smaller, and of less vivid colouration than *S. anna,* the fw. apex is less falcate and more rounded than in the latter, and the hw. shows almost no or none of the pink portion of the other taxa.

Description: ♂ (Figs. 48–49): Ground colour appearing a little fainted, greyish green, mixed with yellow and black scales. Antennae quadripectinate up to the last segment, with ca. 26–27 segments, longest rami 2.6 mm, length in total 13 mm. Legs with long greyish-pink hairs on the tibia. Lfw. 50–51 mm (HT 50 mm), with relatively short and round apex. Fw. ocellus relative small for the group, 7–8.5 mm maximal diameter, apical field dark pinkish violet. Hw. in the median area without any pink parts, even less than in *S. anna,* and easy to separate by this from *S. sinanna* sp. n. and *S. diversa* below. Hw. ocellus 6.5–7 mm maximal diameter. Postmedian zigzag lines of both fw. and hw. wavy, less extending to basal and marginal area than in the other taxa. Submarginal line consisting of an almost connected row of yellowish white triangles, marginally followed by small dots of the same colour. Colour and pattern on ventral side similar, with less prominent zigzag lines.

♂ genitalia (Figs. GP2: 17–18): Uncus similar to *S. anna,* but slightly narrower at base; lateral tips strongly sclerotized and slightly bent inward. Saccus broad and round. Valve apex slightly shorter and round. Ventral valve processi (harpe) longer, narrower and more strongly (rectangularly) bent outward than in *S. anna.* Phallus with a rather long thorn (corresponding to harpe), strongly bent and strongly sclerotized. Dorsal vesica sclerite longer than in *S. anna*.

♀ (Fig. 50): Very similar to the ♂♂, of same colour, with typical sexually dimorphic characters, such as different antennae and more rounded, compact wings. Antennae bipectinate, with ca. 26 segments, longest rami 0.6 mm, length in total 10.6 mm. Tibiae with more pinkish hairs. Lfw. 48 mm, with rounded apex. Fw. ocellus relatively small for the group, 8.5 mm maximal diameter, hw. ocellus 7 mm maximal diameter.

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Ecological observations: In accordance with the hardly accessible area of the species and the few specimens known, not many observations exist regarding its ecology. From reliable data of collected specimens we noted a flight activity in June and July. Specimens were collected at altitudes of 2000–2600 m in eastern Central Tibet.

Preimaginal instars: Unknown.

Saturnia sinanna sp. n.

HT ♂ (Fig. 56): PR China, Sichuan Prov., Abulandan Shan, Dechang, 27°25′ N, 102°6′ E, VII. 2005, leg. local collector, bought III. 2006 from V. SINIAEV, BC SNB 0592, ex CSNB in SMFL.

PTs (all together 164 ♂♂, 17 ♀♀):

China (105 ♂♂, 14 ♀♀): **Sichuan:** 2 ♂♂, 1 ♀ (Fig. 57), same data as HT, ♂ GP 1834/08 SNB, BC SNB 1921, 1922 (CSNB). 5 ♂♂, same data (CSLL). 8 ♂♂, 1 ♀, (SE), Liangshan, Leibo County, 2800 m, IV. 2006, leg. YI (CSLL). — **Yunnan:** 4 ♂♂, (NW), Yunlong, Daxueshan, approx. 4000 m, VI. 2003, leg. LI, GP 1833/08 SNB, BC SNB 0590, 1919 (CSNB). 5 ♂♂, 1 ♀, (NW), Daxueshan, Yongde, 3504 m, V. 2000, leg. YIN (CSLL). 15 ♂♂, (NW) near east Tibet, Daxueshan, Mt. Deying, 2500 m, E. VII. 2002, leg. YING (CSLL). 5 ♂♂, 2 ♀♀, (N), Sanfengshan, Yaoan, 2897 m, VII. 2000, leg. YIN (CSLL). 1 ♂, 2 ♀♀, (NW), Dexin [Deying], Baimaxueshan, 4500 m, VI. 1999, leg. WANG & LI, ♂ GP 393/99 (CSNB). 4 ♂♂, (NW), Deying, Baimaxueshan, ca. 4000 m, VII. 2002, leg. YING et al., BC SNB 1918 (CSNB) (Fig. 59). 5 ♂♂, same data (2 ♂♂ GP 392/99 + 415/99 SNB), CWAN in SMFL. 1 ♂, Centre, Massif du Kang Shau[?], Lac Emehlei, Dali, 2000–2500 m, VII. 1996, [leg.] BOUSQUET, MNHN (Fig. 58a). 2 ♂♂, 3 ♀♀, (SE), Maguan, Suiyuanqing, 2500 m, VII. 2000, leg. LI & TU, BC SNB 0591, 1917 (CSNB). 10 ♂♂, same data (CWAN in SMFL). 1 ♂, Weishan, Weibaoshan, 2600 m, II. 2001, leg. LI (CSNB). 1 ♂, (S), Hei Mt., Lanchang, 2500 m, IV. 1999, leg. LI & WANG (CSLL). 1 ♂, (W), Baoshan Mts, 20 km SW, 2400 m, 23.–25. V. 2006, leg. S. MURZIN & I. SHOKIN (CSLL). 5 ♂♂, 1 ♀, Kunming env., hatched in Berlin from cocoons collected in the wild (by Victor WU) on 1.–15. VI. 2005 (♂♂), 26. V. 2005 (♀) (CSNB). "Tibet" [recte Yunnan]: 5 ♂♂, Jiulong County, Shangri La, 3200 m, 6. VI. 2004, leg. G. BRETSCHNEIDER (CSLL). 1 ♂, N, Wei-Si-Bahand, Père OUVRARD, J.-Bet., 1918, GP SNB 414/99 (NHMW). 2 ♂♂, Tse-kou [missionary station, 28° N, 98°5′ E, 2285 m], 1893 & 1900, R. P. DUBERNARD (NHMW). 8 ♂♂, Baoshan, Changning, VII. 2009 (CSNB). 5 ♂♂, 1 ♀, Kunming env., ex pupa 2005 (CSKK). 1 ♂, Diancang Shan, 25°41′ N, 100°5′ E, 2200 m, 15.–30. VII. 2004, leg. V. SINIAEV & team (CSKK). 1 ♂, S, Wongding Forest area, 2500 m, ca. 20 km W Changyuan, IX. 1999, leg. WANG & LI, ex CSNB (CWAN in SMFL). — **Guangxi:** 7 ♂♂, 2 ♀♀, (W), Xiling, Datouzhang Mt., 1600 m, VII. 2003, leg. LI et al., ♂ GP 1835/08 SNB, BC SNB 0593, 1923, 1924 (CSNB).

Vietnam (59 ♂♂, 3 ♀♀): 5 ♂♂, 2 ♀♀, (N), Mt. Fan Si Pan W-Seite, Chapa env., 1600–1800 m, 22°20′ N, 103° 40′ E, IX. 1994, leg. MONG, ♂ GP 480 PAUKSTADT (CSNB). 25 ♂♂, same locality, of which: 2 ♂♂ VII. 1994, R. BRECHLIN (♂-GP 857 + 858/95 NÄSSIG); 8 ♂♂, IX. 1994, leg. MONG, c/o A. SCHINTLMEISTER; 15 ♂♂, VI.–VIII. 1995, leg. local coll., c/o A. SCHINTLMEISTER, all in CWAN in SMFL. 4 ♂♂, (N), Mt. Fan Si Pan, Chapa env., 1600–1800 m, IV. [?]1995, leg. SINIAEV & local coll., BC SNB 0594 (CSNB). 7 ♂♂, (N), Mt. Fan Si Pan, Chapa env., 1600–1800 m, IX. 1995, leg. SINIAEV & local coll., GP 133 & 134/07 SNB, BC SNB 0376, 1925, 1926 (CSNB). 1 ♂, Chapa, IV. 1995 (coll. BROSCH, Hille). 1 ♂, (N), Lao Cai Prov., Mt. Fan Si Pan, Nui Se, 22°21′ N, 103°46′ E, 1930 m, VIII. 2000, leg. Hoa Binh NGUYEN (CSLL). 5 ♂♂, 1 ♀, same data, but VIII./IX. 2001 (CSLL). 1 ♂, same data, but VII./VIII. 2001 (CSLL). 1 ♂, same data, but 27.–29. VIII. 2006 (CSLL). 9 ♂♂, Mai-chau, 20°50′ N, 104°50′ E, 40 km SE Moc-chau, 1400 m, 7.–15. IV. 1995, leg. SINIAEV, c/o A. SCHINTLMEISTER in CWAN in SMFL.

Type labels will be added accordingly.

Here illustrated: Figs. 56–65; GP2: 19–22; PIP II: b–i, t–x; Map 3.

Derivatio nominis: Named as the Chinese relative of *S. anna* (although more widely distributed).

Cited in literature as:

Caligula anna: DE JOANNIS (1929: 293); BOUVIER (1936: 212); ZHU & WANG (1983: 413, pl. 135, fig. 2975 ♂; 1993: 282; 1996: 138, pl. VIII, fig. 4 ♂); XUE & WANG (1989: 45, pl. X, fig. 1 ♀).

Caligula ?sp.: D'ABRERA (1998: 38, 39, fig. ♂, ♀).

Saturnia (Rinaca) anna: NÄSSIG (1994b: 341, 349).

Note: ZHU & WANG (1993) provide further data (exceeding the listed areas in Yunnan, Sichuan and Guangxi above) under the name *"Caligula anna"* which in reality probably deal with *S. sinanna:* Guangdong and Hainan. We have not seen material of the *grotei*-group from these provinces so far (although there was much saturniid material received from there in recent years), but the presence of *S. sinanna* does not appear to be unlikely there. The authors also add some foodplant data (ZHU & WANG 1993: 60), which may as well be associated with *S. sinanna:* "Chinese Tallow tree" [*Triadica sebifera* = *Sapium sebiferum,* Euphorbiaceae], *Cinnamomum camphora, Juglans* sp.

Distribution (Map 3): *Saturnia sinanna* is a rather widely distributed species in China: Sichuan, Guanxi and Yunnan (possibly also crossing the Yunnanese border to today's Tibet for some distance? Traders' distribution data are sometimes hard to clear and confirm), possibly also in some other southern provinces, and further in northern Vietnam.

Diagnosis: *S. sinanna* is the most vividly coloured (in contrasting greenish-yellow and pink) species within the complex of *S. anna,* also characterized by the largest fw. and hw. ocelli and the most rounded fw. apex which is bent outward in the ♂♂ (thereby showing a combination of a falcate fw. shape with a circularly rounded fw. apex), and a large black portion of the wing ocelli in both sexes. It is usually smaller and brighter than *S. diversa.* A reliable and doubtless morphological differentiation between imagines of *S. sinanna* and *S. diversa* based on singletons is often not possible; however, the mtDNA COI barcode data always provided small, but reliable differences thus far, and the larvae appear to be quite clearly distinct (see Tab. 3).

Description: ♂ (Figs. 56, 58–59, 62–63): Ground colour dark yellowish-green, mixed with yellow and black scales; older specimens are fading to a more yellowish colour. Antennae quadripectin-

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Preimaginals plate II: Species-complex of *Saturnia anna*. Orange lines separating species. **Fig. a:** ***Saturnia tsinlingshanis,*** China, Shaanxi, Tsinlingshan, ca. $L_{[4?]5}$. Reared by V. SINIAEV; no more data available (phot. V. SINIAEV). — **Figs. b–i:** ***S. sinanna,*** China, W-Yunnan, Yunxian, Songzishanding, 2800 m, ♀ collected 30. VI. 2003, YING; reared by S.N., VII./VIII. 2003, in Germany on *Liquidambar styraciflua* (phot. S.N.). **Fig. b:** L_1, 17. VII. **Fig. c:** L_2, 24. VII. **Fig. d:** L_3, 7. VIII. **Fig. e:** L_4, 7. VIII. **Fig. f:** L_5, 10. VIII. **Fig. g:** L_5, 10. VIII. **Fig. h:** cocoon, 20. XI. (hibernating). **Fig. i:** pupa in opened cocoon, 20. XI. (hibernating). Photos S.N. — **Figs. j–s:** ***S. diversa,*** India, Nagaland, West of Kohima, on *Salix* sp., in 2008 in Moscow. Regrettably no L_1 and L_2 was photographed, but see Fig. s. **Fig. j:** ♀ in the wild, 7. IV. 2008. **Fig. k:** ca. L_3. **Fig. l:** ca. $L_{3/4}$. **Figs. m–n:** ca. L_4; **m:** lateral view; **n:** anal end. **Figs. o–q:** ca. L5; **o:** basolateral view; **p:** dorsolateral view; **q:** anal

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end. **Fig. r:** freshly built cocoon. Photos V. Siniaev. — **Fig. s:** L_1, India, Nagaland (phot. S. Kohll). — **Figs. t–x:** ***S. sinanna,*** Yunnan, vic. Kunming, reared 2005 by S. Kohll, larvae died in L_3. **Fig. t:** L_1; **Figs. u–v:** L_2; **Figs. w–x:** L_3. — Photos S. Kohll.

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ate, with ca. 28 segments, longest rami 2.7 mm, length in total 12–12.5 mm. Legs with long pink hairs on the tibia. Lfw. 45–51 mm (HT 48 mm), with relatively falcate wingshape, but evenly rounded apex with a violet apical field. Fw. ocellus relatively large, almost circular, 8–12 mm maximal diameter, with outer black ring, followed centrally by a broad brownish-pink portion and an inner black part. Hw. in the median area towards upper margin heavily mixed with pinkish red scales and hairs on dorsal side, much more intensive than in the more greenish *S. anna*, but less than in *S. diversa*. Hw. ocellus 7–10.5 mm maximal diameter. Postmedian zigzag lines of both fw. and hw. very wavy, curved relatively wide to basal and marginal areaa. Submarginal line consisting of a row of yellow, sometimes connected triangles, marginally followed by small dots of the same colour. The hw. margin has usually a typical outer angle about 10 mm from anal margin. Colour and pattern on ventral side similar, with less prominent zigzag lines; a pink portion of the hw. is completely lacking.

♂ **genitalia** (Figs. GP2: 19–22): Uncus rather narow at base, apical tips of lateral processi slightly less sclerotized than in *S. diversa*. Saccus often longer than in *S. diversa*. Apical part of valve often narrower and less convex than in *S. diversa,* the ventral process (harpe) rather long and slender on a sclerotized base, on average more fragile than in *S. diversa*. Phallus with a long and broad thorn, slightly more dorsally bent than in *S. diversa;* sclerite round, dentate.

♀ (Figs. 57, 60–61, 64–65): Very similar to the ♂♂, of same colour, with typical sexually dimorphic characters, such as different antennae and more rounded, compact wings. Antennae quadripectinate, with ca. 25 segments, longest rami 0.7 mm, length in total 10 mm. Tibiae also with pink hair. Lfw. 50–52 mm, with round apex. Fw. ocellus relatively large for the group, 9.5–11.5 mm maximal diameter, hw. ocellus 7.5–8.5 mm diameter. The hw. in all known specimens with similar pink portion as in the ♂♂.

Ecological observations: In China, *S. sinanna* was collected so far in IV.–VII. with a very early singleton also in II. In Vietnam, with a more tropical habitat, specimens were also collected in VIII.–IX. (i.e., possibly more than one generation per year?). The altitudes given in the locality list refer mainly to the notes by the Chinese dealers, and we strongly suppose that altitudes given as e.g. 4000 or even 4500 m for Yunnan refer to the height of the mountain top rather than to the real collecting locality somewhere on its slopes; serious data found by European collectors range over altitudes of 1600–2400 m, with a peak of 3200 m in NW Yunnan (former "East Tibet").

Parasitic wasps of the genus *Enicospilus* (Ophioninae; determination R. S. Peigler) hatched from some wild collected cocoons originating from Kunming env., Yunnan.

Preimaginal instars: Very likely it was this species which was reared and documented photographically by S.N. from China, W-Yunnan, Yunxian (leg. Ying), in 2003 (Figs. PIP II: b–i; also t–x) on *Liquidambar styraciflua*. However, no imagines hatched from the hibernating pupae, thus the identity of these caterpillars was not confirmed. It might be argued that this rearing had been one of *S. diversa;* both species are known to occur in this area. However, we also know the larvae of *S. diversa* from India: Nagaland (see below), and they differ from the one described here; so we accepted them as *S. sinanna* for the time being and describe them here as such.

Description of the preimaginals: For a comparison with *S. diversa* and *S. tsinlingshanis,* see illustrations on PIP II and Tab. 3.

Saturnia diversa (Bryk, 1944), stat. n., comb. n.

Caligula anna diversa Bryk (1944: 15; pl. III, fig. 21 HT). —HT ♂ (original designation); NRSS. — L.t.: [Myanmar], NE-Burma [Kachin State, at the Yunnan border, ca. 10 km W Jiangao Shan], Kambaiti, 2000 m, 2.–8. IV. 1934.

Here illustrated: Figs. 10, 66–74; GP2: 23–26; PIP II: j–s; Map 3.

Cited in literature as:

Caligula anna diversa: Naumann et al. (2008: 151; original combination retained).

Caligula anna: D'Abrera (1998: 36, 37, fig. ♂).

Distribution (Map 3):

Myanmar: Kachin State: Chinese borderline, Kanphant, 26° 8′51.2″ N, 98°34′58.2″ E, 1642 m (CSNB, CSLL). Rd. Kanphant–Mt. Inwa Bum near pass, 26°10′31.9″ N, 98°30′3.4″ E, 3008 m (CSNB, CSLL). Rd. Kanphant–Mt. Inwa Bum, 26°9′38.8″ N, 98°30′53.5″ E, 2440 m (CSNB, CSLL). Rd. Kanphant–Mt. Inwa Bum, 26°9′23.2″ N, 98°31′16.4″ E, 2358 m (CSNB, CSLL). Rd. Chibwe–Pan Wah, 2 km N branch to Kanphant, 25°43′30.2″ N, 98°32′35.3″ E, 2180 m (CSNB, CSLL). Pan Wah, 2200 m (CSNB). Chudu Razi Hills, ca. 40 km E Kawnlangphu (CSNB). (NW), Balaishan, Xiadushuai, 2900 m (CSLL). — **Sagaing State:** E Ngalung Ga, SSE Kumki (India), Tarung Hka river fork, 27°7.875′ N, 96°53.105′ E, 1000 m (CSNB). — **Chin State:** Natma Taung N.P., rd. Mindat–Matupi, 30 miles camp, 21°29′47.0″ N, 93°47′21.9″ E, 2495 m (CSNB, CSLL). Natma Taung N.P., road Mindat–Matupi, 20 miles camp, 21°25′15.2″ N, 93°47′21.5″ E, 2350 m (CSNB, CSLL). Natma Taung N.P., road Mindat–Matupi, 8 km W Mindat, avodaco plantation, 21°23′34.7″ N, 93°52′29.4″ E, 1914 m (CSNB, CSLL). Natma Taung N.P., 5 km W Kanpetlet, 1750 m (CSNB, CSLL). Natma Taung N.P., way to Mt. Victoria, 21°12′ N, 93°59′ E, 2000 m (CSNB).

India: Nagaland, W Kohima, 25°40′ N, 94°2′ E, 1900 m (CSNB, CSLL). Naga Hills, ca. 2000 m (MNHN).

China: Tibet: (E), Meilixueshan, Yanging env., "6000 m" [*sic*, collectors' data] (CSNB, CWAN in SMFL). — **Yunnan:** (NW), Dali Bai autonom. pref., Yunlong County, Fengshuining Mts., 13 km N Caojian, 25°46′ N, 99°6′ E, 2460 m (CSNB, CWAN in SMFL).

Saturnia diversa is found from the Yunnan/Myanmar border (Kachin State) in the East over (in the North) northern Yunnan/E Tibet and (in Myanmar) the Chudu Razi hills and northern Sagaing State to Nagaland (India) and (again in Myanmar) Chin State, Mt. Victoria area, in the West. There is some overlap of the areas with *S. bieti* and *S. sinanna* in Kachin State and Yunnan.

Diagnosis: *S. diversa* is characterized by its generally dark greenish ground colour with a yellowish tint, intensively pink coloured basal and central parts of the hw., relatively large and dark fw. and hw. ocelli, a rounded fw. apex which is bent outward in the ♂♂, and large black portion of the wing ocelli in both sexes.

Description: ♂ (Figs. 66–67, 69–70, 72–73): Ground colour dark green, mixed with yellow and black scales; older specimens are fading to a more yellowish colour. Antennae quadripectinate, with ca. 26 segments, longest rami 2.6 mm, length in total 12.5 mm. Legs on the tibia with long greyish-pink hairs. Lfw. 50–58 mm (HT 57.5 mm), with relatively falcate apex. Fw. ocellus relatively large, 9–11.5 mm maximal diameter, with strong outer black ring and inner black portion. Hw. dorsally in the median area towards upper margin heavily mixed with pinkish-red scales and hairs,

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much more intensive than in the more greenish *S. anna*. Hw. ocellus 6–9 mm maximal diameter. Postmedian zigzag lines of both fw. and hw. very wavy, reaching widely to basal and marginal area. Submarginal line consisting of a row of yellowish-white triangles, marginally followed by small dots of the same colour. Colour and pattern on ventral side similar, with less prominent zigzag lines, the pink portion of the hw. is completely lacking.

♂ **genitalia** (Figs. GP2: 23–26): Uncus rather narow at base, apical tips of lateral processi rather short, strongly scleritised, widely separated. Saccus short and round. Apical part of valve similar to *S. sinanna,* but often slightly shorter. The ventral process (harpe) rather long and slender on a sclerotized base, on average less fragile than in *S. sinanna;* sacculus well developed. Phallus with a long and broad thorn; sclerite round, dentate.

♀ (Figs. 68, 71, 74): Very similar to the ♂♂, of same colour, with typical sexually dimorphic characters, such as different antennae and more rounded, compact wings. Antennae quadripectinate, with ca. 28 segments, longest rami 0.8 mm, length in total 12 mm. Tibiae with more greyish hair, but still with pink touch. Lfw. 50–56 mm, with round apex. Fw. ocellus relatively large for the group, 8.5–11 mm maximal diameter, hw. ocellus 7.5–9 mm. The hw. often with less prominent pink portion, compared to the ♂♂.

Ecological observations: *S. diversa* obviously has more than one generation per year, or specimens hatch quite irregularly over a long period. Specimens were collected in III.–VII. and (rarely) in X., with a peak in V.–VI. The species was collected at altitudes of 1000–3000 m, with most specimens originating from 1600–2450 m. Reported flight activities in West Myanmar, Chin State, are 21:10–23:20 h for ♂♂ and 20:00–20:20 h for ♀♀, and in NE Myanmar, Kachin State, from 23:40–4:00 h for ♂♂ only. In very high altitudes of Kachin State it occurs syntopically with S. *bieti,* but with a different flight activity period at night (see under *S. bieti*).

Preimaginal instars: In 2008, V. SINIAEV reared *S. diversa* from India, Nagaland, West of Kohima (collected specimens from that source in CSNB with barcode), on *Salix* sp. and documented the larval instars (Figs. PIP II: j–s). The L_1 larva is black, as is true for all members of the *anna*-complex where this is known. Last instar larvae show very conspicuous scoli with sky blue colour. For a more detailed comparison with *S. diversa* and *S. tsinlingshanis,* see illustrations on PIP II and Tab. 3. — Ova deposited during an expedition to Myanmar, Kachin State, and another time to Chin State, both carried out by M. LANGER, S. LÖFFLER and S.N., died on the way back and did not result in any larvae. The ova were reddish brown, with a size of 1.8 mm × 1.3 mm × 1.1 mm in both cases (compare to *S. bieti* above).

Discussion of the *anna*-complex

The 6 species of the *anna*-complex fall clearly into two subcomplexes in the mtDNA barcode: the *bieti*-subcomplex with two species, *S. bieti* and *S. tsinlingshanis,* and the *anna*-subcomplex with the remaining 4 species.

The differences in the barcode similarity analysis are below 2 % between *S. bieti* and *S. tsinlingshanis,* but there are additionally clear morphological differences, and both species show distributional overlap in Yunnan.

For the other species, *S. anna* (being a rather widely distributed species along the southern slopes and mountains of the Himalaya range) and *S. tibetanna* (found in Tibet in the dryer areas with less precipitation) appear to be well-separated by all characters, and also *S. sinanna* and *S. diversa* (which can be externally quite similar to each other) are sufficiently separate. This point of view is supported by distributional overlap especially in Yunnan and Sichuan for several of the species (see Map 3). The morphological differences between *S. sinanna* and *S. diversa* are sometimes problematic, except for the larvae.

Preimaginal morphology is much less known than for the *grotei*-complex (more or less full information is available only for *S. sinanna* and *S. diversa,* partial information for *S. tsinlingshanis*), but the differences support the separation into species. The only known L_1 larvae (for *S. sinanna* and *S. diversa*) are totally black; *S. sinanna* has a somehow "rectangularly-shaped" L_5 larva, caused by the large and elongate basolateral scoli on abdominal segment 8, while the larva of *S. diversa* is rather unique in its colouration (blue scoli). The scoli (especially the dorsal ones) on a9 are usually enlarged and conspicuous and combined with conspicuous colouration of the anal plate and the anal legs; this character is shared with the larvae of the *lindia*-subcomplex. The cocoons (known for *S. sinanna* and *S. diversa*) are similar to those of *S. lindia* and *S. bonita* for their elongate shape and for the external, large, preformed exit of "Reuse" type, but, in contrast, show the net-like, open-meshed perforated wall known from the majority of the other species of *Saturnia s.l.* (where the preformed exit is usually better integrated into the cocoon shape and not appearing so "attached").

Conclusive discussion

The *grotei*-group of the genus *Saturnia* as defined here counts 11 species and inhabits an area from Afghanistan in the West to Shaanxi, Guangxi and Vietnam in the East, mostly along the Himalaya range and adjacent mountain chains. The ♂ genitalia are rather similar, not only within the group, but also in comparison with related groups (e.g., the *boisduvalii*-group etc.). Based on ♂ genitalia morphology alone, a reliable splitting into different species was not possible. External morphology, zoogeography (sympatry) and especially the mtDNA barcode analysis allowed much more clearly a subdivision for the taxa, and the (only partly known) larval morphology supports this. Nothing is known presently about, e.g., pheromones and many other aspects of the species involved. Nevertheless, the species of the genus *Saturnia* in the wide sense (e.g., NÄSSIG 1994a) share a lot of characters, and the study of its evolution and the analysis of the presently existing species is still quite promising.

Ideas about the relationships of the *grotei*-group

The *grotei*-group as described here, consisting of 11 species, is obviously monophyletic, as indicated by morphology (general similarity in habitus and ♂ genitalia,

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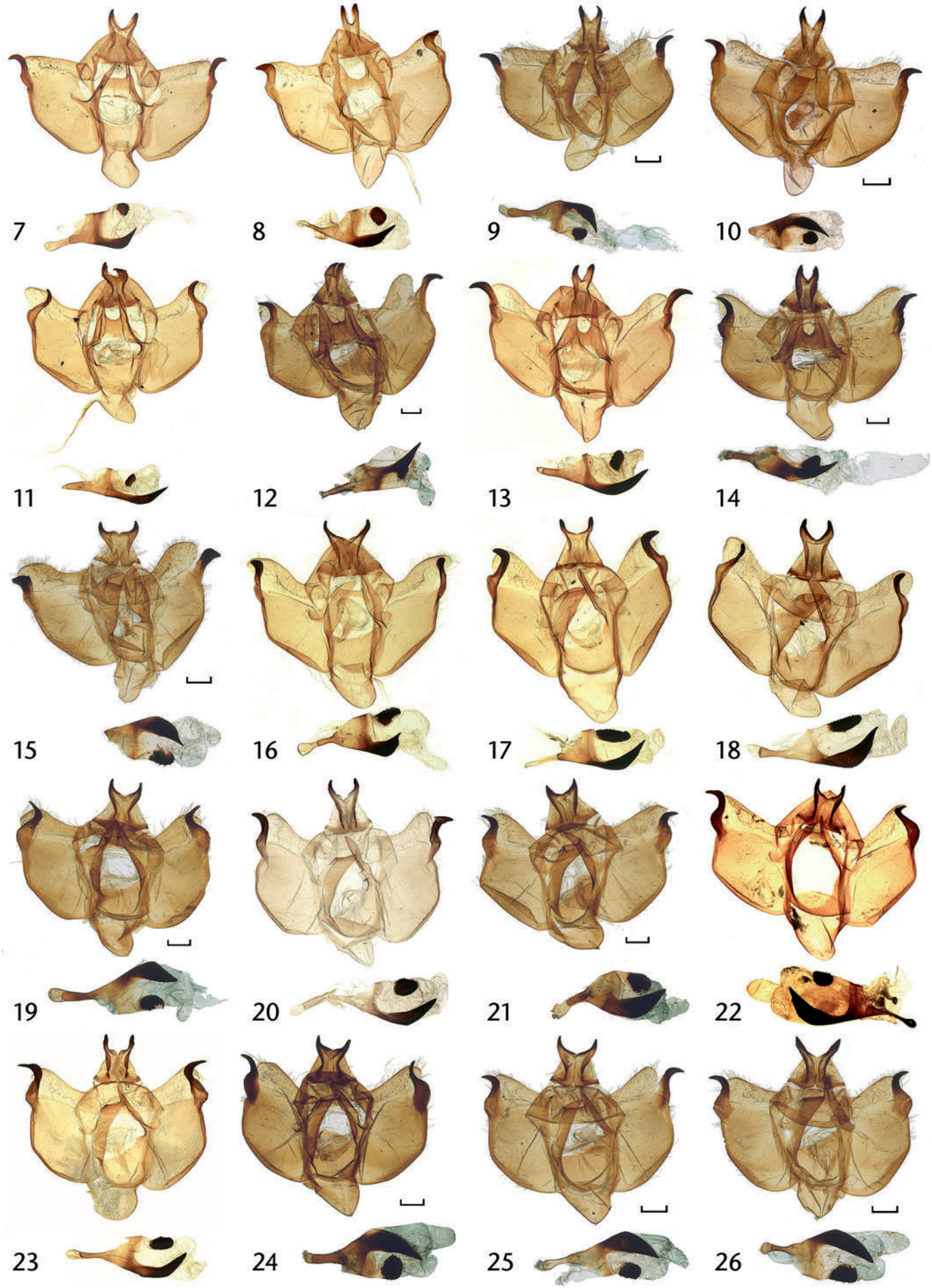

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obviously also in larval morphology, as far as known today) and barcode data (see Fig. 1). Two of the species are known (or at last supposed) to have diurnal ♂♂ and nocturnal ♀♀: *S. grotei* and *S. paragrotei;* in all other species both sexes appear to fly at night.

Diurnal ♂♂ are also known or supposed for *S. kitchingi* and *S. nanlingensis,* which in the early 2000s gave us support for including these taxa tentatively into the *grotei*-group; in fact, the ♂♂ look externally quite similar to *S. grotei*. Recent barcode results, however, suggested that these 2 species, in contrast, are members of the species-group around *Saturnia boisduvalii* Eversmann, 1846, with which they also share some details of the ♂ genitalia. The diurnal flight activity of the ♂♂ of these two species would appear to be a homologous acquisition of them, independent from *S. grotei*/*S. paragrotei,* and the blackish habitus can as well just be a homology.

The rather strange species *Saturnia (Rinaca) winbrechlini* Brechlin, 2000 as well as *S. (R.) witti* Brechlin, 1997 and the very similar *S. (R.) pelelaensis* Brechlin, 2009 had in the early days before the year 2000 induced some thoughts about their relationship to the *cachara*-group or the *grotei*-group, but these species clearly also belong to the *boisduvalii*-group, as indicated both by barcode and morphology (see, e.g., Brechlin 2009b). These two groups (*grotei*- and *boisduvalii*-groups) appear to be relatively closely related (although they are evidently not directly sister-groups), and their respective monophyly is only indicated comparatively clear in the barcode similarity trees, less so in morphology.

The *grotei*-group appears to have derived from one species in the Himalaya and adjacent mountain ranges to the East in Asia; the first separation obviously was one species to the West within the Himalaya (= today the *grotei*-complex) and another species to the East (= today the *anna*-complex), and evidently these two complexes have further speciated relatively recently within the mountain ranges (Himalaya, Chinese and Tibetan highlands and adjacent mountains), perhaps mostly during the Quaternary glaciations, with successive secondary re-invasions into former habitats during warmer times (with or without interbreeding with their former conspecifics at the beginning of the renewed contact?). As usual for such mountain species, the different populations appear to be well-separated in terms of genetic exchange, which probably explains for the sometimes quite large differences in mtDNA COI sequences (barcode).

We have interpreted these differences as species-specific here; however, there remains some doubt about the status for some of the taxa, and additional support should be searched from other characters. We admit that further studies may come to different results (see, for example, Hebert et al. 2004 vs. Brower 2006 for a possibly similar case in Hesperiidae, or the study by Wiemers & Gottsberger 2010 for *Iphiclides podalirius* (Linnaeus, 1758) in the western Palaearctic). The barcoding method is often, but not always, practicable for species identification, and the use of barcode data for higher systematics may be even more problematic sometimes (compare, for example, the general critics by Will et al. 2005). We do not yet know enough about the taxa involved to reliably apply the concept of "integrative taxonomy" as suggested by Dayrat (2005), Will et al. (2005) and other authors — we have just begun our studies.

The geographical overlap of the eastern *anna*-complex and the western *grotei*-complex is rather restricted, but in localities in Nepal, Sikkim, northern West Bengal and Bhutan the distributional area of the S. Himalayan species *S. anna* well overlaps with that of several species of the *grotei*-complex.

Check-list of the species-group of *Saturnia grotei*

Species-complex of *Saturnia grotei*

Saturnia grotei Moore, 1859

Saturnia paragrotei Naumann & Nässig, 2010 (sp. n.)

Saturnia lindia Moore, 1865

- = *Saturnia hockingii* Moore, 1888; syn.
- = *Caligula lindia* "ab." [= f.] ǂ*sillemi* Bouvier, 1935 [infrasubspecific, unavailable]
- = *Caligula lindia sillemi* Bouvier, 1936; syn. n., comb. n.

Saturnia rosalata Naumann & Nässig, 2010 (sp. n.)

Saturnia bonita (Jordan, 1911)

Species-complex of *Saturnia anna*

Saturnia bieti Oberthür, 1886

- = *Caligula anna dejeani* Bouvier & Riel, 1931; syn. n.
- = *Caligula anna yunnana* Mell, 1939; syn. n.

Saturnia tsinlingshanis (Mell, 1939); comb. n.

Saturnia anna Atkinson (*in* Moore), 1865

Saturnia tibetanna Naumann & Nässig, 2010 (sp. n.)

Saturnia sinanna Naumann & Nässig, 2010 (sp. n.)

Saturnia diversa (Bryk, 1944); stat. n., comb. n.

Genitalia plate 2: ♂ genitalia of *Saturnia* spp., species of the *anna*-complex. **Figs. 7–10:** ***Saturnia bieti*. Fig. 7:** China: Yunnan, SNB 0038/96. **Fig. 8:** China, Yunnan (PT ZFMK *Caligula anna yunnana*), SNB 0139/97. **Fig. 9:** China, Sichuan, SNB 1837/08. **Fig. 10:** Myanmar, SNB 1772/08. — **Figs. 11–14:** ***S. tsinlingshanis*. Fig. 11:** China, Shaanxi, PT ZFMK, SNB 0053/97 (labelled *"‡macroocellata"*). **Fig. 12:** China, Shaanxi, SNB 1836/08. **Fig. 13:** China, Sichuan, SNB 0135/97. **Fig. 14:** China, Yunnan, SNB 1838/08. — **Figs. 15–16:** ***S. anna*. Fig. 15:** Bhutan, SNB 1829/08. **Fig. 16:** Nepal, SNB 0138/97. — **Figs. 17–18:** ***S. tibetanna*. Fig. 17:** China, Tibet, SNB 0146/97. **Fig. 18:** China, Tibet, SNB 0337/99. — **Figs. 19–22:** ***S. sinanna*. Fig. 19:** China, Sichuan, SNB 1834/08. **Fig. 20:** China, Yunnan, NHMW, SNB 0414/99. **Fig. 21:** China, Guangxi, SNB 1835/08. **Fig. 22:** Vietnam, SNB 0133/97. — **Figs. 23–26:** ***S. diversa*. Fig. 23:** Myanmar, Kambaiti, PT NRSS, SNB 0336/99. **Fig. 24:** Myanmar, Kachin, SNB 1832/08. **Fig. 25:** Myanmar, Chin, SNB 1830/08. **Fig. 26:** India, Nagaland, SNB 1828/08. — Not to the same scale; scale bars (where present) = 1 mm.

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